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INTRACRANIAL ARTERIAL ANEURYSMS IN THE CAROTID CANAL

DIAGNOSIS AND TREATMENT

WALTER E. DANDY, M.D.

BALTIMORE

Aneurysms of the cranial division of the internal carotid artery may arise (1) in the carotid canal and (2) within the cranium. There may or may not be differences in the signs and the symptoms of the two types, and the surgical attack which has been developed in the past few years may or may not be the same for both. The only symptomatic difference between aneurysms in these two locations is that many of those in the cavernous sinus produce disturbances of the trigeminal nerve while those of the intracranial portion do not. Nearly all aneurysms in the carotid canal are amenable to operative treatment with minimal risk; those in the intracranial division may or may not be curable, depending on the exact relation to the branches at the circle of Willis. I am concerned in this publication only with the arterial aneurysms in the carotid canal, particularly with the large ones. This location is also a favored seat for carotid-cavernous arteriovenous aneurysms with resultant pulsating exophthalmos, but these have been considered elsewhere. Rupture of the smaller arterial aneurysms in this region is indeed one source of the arteriovenous variety, and 1 of my cases has been included because this finding was present at necropsy. Most of the arteriovenous aneurysms in this position are of traumatic origin and are a common result because the torn internal carotid actually traverses the cavernous sinus.

REPORT OF A CASE OF A LARGE ANEURYSM ARISING IN THE CAROTID CANAL

The patient was a rather frail woman 52 years of age. She was referred by Dr. Warde B. Allan, of Baltimore, on Nov. 19, 1941, with the probable diagnosis of an intracranial aneurysm (fig. 1). Dr. Frank Ford, the neurologist at Johns Hopkins Hospital, made the same diagnosis. The illness for which she was admitted to the hospital began three years before with diplopia which lasted a month and was said to have been corrected by glasses. However, it recurred periodically during the next three years. Four months before admission a tingling sensation in the right maxillary region and quickly thereafter numbness of the cheek and

forehead appeared. At the same time severe pain struck the right eye. Three weeks later, a sudden piercing headache developed in the right frontal region; this was accompanied by nausea and vomiting. On the following morning, the pain had concentrated in the right eye, and the right upper eyelid drooped (ptosis). The pains and the headache persisted, although for the last three weeks there was gradual improvement and for the last week they were barely noticeable. A spinal puncture had been made at the Gorgas Hospital at Ancon in the Panama Canal Zone six weeks before and was entirely negative.

The following findings were elicited on examination of the eyes by Dr. Frank Walsh, who also suggested an intracranial aneurysm: (1) total paralysis of all extraocular muscles on the right side (the third, fourth and sixth nerves); (2) exophthalmos of 4 mm. of the right eye; (3) enlargement and absence of

Fig. 1.—Photograph of the patient with a large carotid cavernous aneurysm showing complete ptosis and moderate exophthalmos.

reaction in the right pupil; (4) visual acuity, 20/50 for the right eye and 20/20 for the left; (5) small central scotoma on the right and normal fundi; (6) anesthesia of the first and second branches of the right trigeminus nerve; (7) destruction of the anterior and posterior clinoid processes on the right (no calcified shadows); (8) blood pressure, 192 systolic and 100 diastolic; negative Wassermann test.

In 1941, I reported the cases of 5 presumably cured patients with carotid aneurysms in the carotid canal. The cure was accomplished by trapping the aneurysm between a clip on the intracranial carotid and a total ligation in the neck. All of these patients were fairly young; the collateral circulation was adequate, and the aneurysms were small. I had feared that huge aneurysms of this type would probably be beyond hope of operative treatment, although I had not yet exposed one at operation. It was assumed that the intracranial portion

of the internal carotid artery would probably be hidden from view by the large intracranial protrusion of the aneurysm and furthermore that the possible collateral circulation through the circle of Willis would be compromised by the projection of the mass on the anterior and posterior communicating arteries. As is so frequently true, this supposition proved to be unfounded, and the problem, although not as simple as that of the smaller aneurysms because of other considerations, was solved without undue difficulties.

The collateral circulation was indeed demonstrated to be entirely inadequate by the Matas test, i. e., compression of the internal carotid artery in the neck. Total occlusion of this vessel could be tolerated less than a minute, and, therefore, ligation of the vessel without disastrous cerebral sequelae was precluded. However,

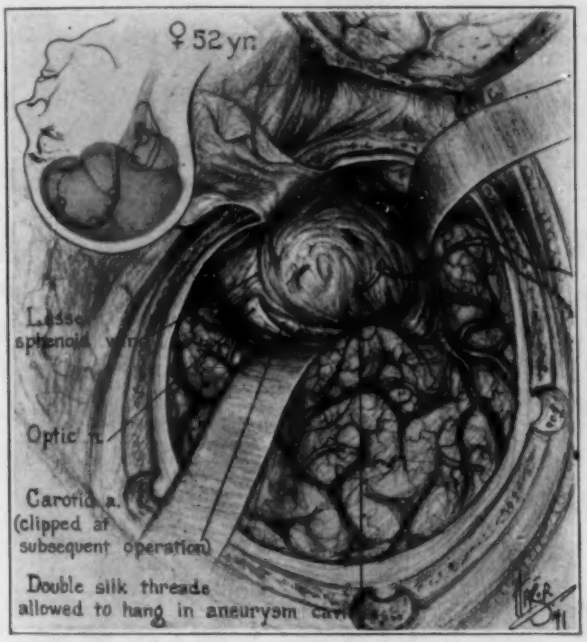

Fig. 2.—Operative sketch of carotid aneurysm in the cavernous sinus bulging far up into the temporal fossa. Since the Matas test indicated that the internal carotid could not be ligated without cerebral disturbances, a series of sutures was introduced into the aneurysm with the hope that they might cause a clot to develop and obliterate the aneurysm.

after partial occlusion of the internal carotid artery in the neck by a fascial band, the collateral circulation was found to be adequate, and four days later, the internal carotid was totally occluded intracranially by a silver clip and in the neck by a ligature (over the fascial band), thus trapping the aneurysm (fig. 3). Between the two ligatures there is only one sizable branch of the internal carotid artery, namely, the ophthalmic artery, and this, I believe, will not maintain the aneurysm. At least in none of the other 5 patients reported as cured has there been a suggestion of failure by subsequent signs or symptoms.

At the time of the final operation the internal carotid was simultaneously exposed intracranially and in the neck. When the silver clip was clamped on

the internal carotid artery within the cranial chamber, there was no visible effect on the violent pulsation of the aneurysm. Perhaps five minutes later the internal carotid was ligated with silk in the neck, and all pulsation in the aneurysm immediately stopped. It is probably worthy of note that the intracranial ligation was performed first. It perhaps made no difference which ligature was placed first since the time interval between the two ligatures was so short, but with a longer interval there is reason to believe that cerebral emboli may be prevented by ligating this artery intracranially first. It may or may not be important to place both ligatures almost simultaneously, but the thought occurred that an aneurysm not receiving blood would be smaller and therefore compromise the collateral circulation through the circle of Willis to a lesser degree. Recovery

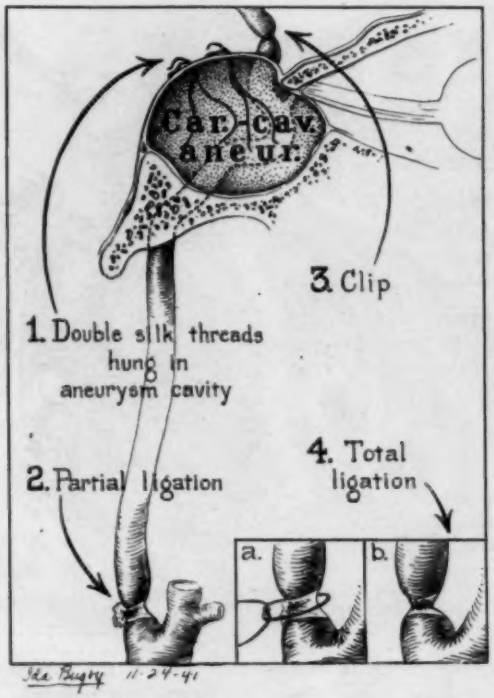

Fig. 3.—The final treatment of the aneurysm is indicated in this sketch. First the internal carotid was partially closed with a fascial band. Four days later, the internal carotid was clipped intracranially and ligated in the neck. A silk ligature was tied over the fascial band.

from the operation was uneventful and without any trace of cerebral involvement. It also should be added that at the time of the initial exposure of the aneurysm five days before these ligations, four double silk sutures of medium size were left dangling in the interior of the aneurysm (fig. 2). Each of the eight sutures was about 2 cm. in length. Owing to the thick capsule of the aneurysm, long curved needles could be passed through the aneurysmal wall and pulled until one end of the suture was left dangling inside. There was no evidence from the degree of pulsation of the aneurysm that they had induced a thrombus.

Perhaps in the smaller berry aneurysms they may be more effective and may possibly offer a means of curing those that cannot be extirpated or clipped at the neck of the sac.

The chronology of events in the surgical treatment of the aneurysm was: (1) exposure of the aneurysm intracranially on Nov. 24, 1941 (fig. 2); (2) partial ligation of the internal carotid in the neck on Nov. 25, 1941; (3) clipping of the internal carotid intracranially and total ligation in the neck on Nov. 29, 1941 (fig. 3); (4) discharge from the hospital on Dec. 22, 1941.

Subsequent Course.—The patient was examined by Dr. Walsh two months after the operation, on Jan. 28, 1942; at that time she was free from all symptoms and had been since operation. The vision in the affected eye had returned to 20/20 (from 20/50), and the central scotoma had disappeared. She could elevate the upper lid so that the entire pupil was exposed. The eye abducted 35 and adducted 7 degrees; it moved upward 2 and downward 2 degrees. Before operation the eyeball had been fixed. The exophthalmos had not diminished. She was then returning to her home in Panama.

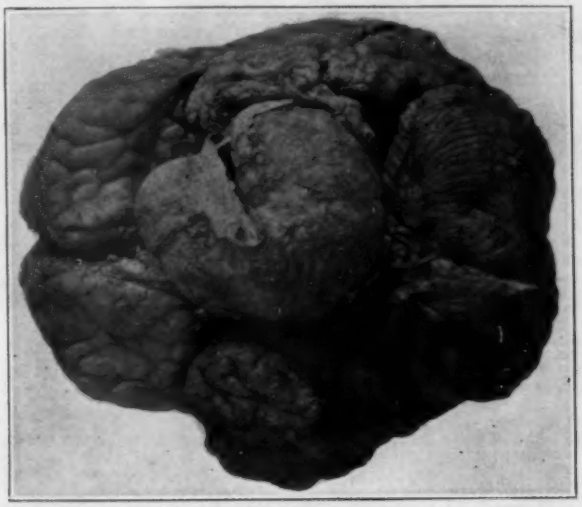

Fig. 4.—Postmortem specimen of huge bilateral carotid aneurysms in the carotid canal (previously reported).

Heretofore, an interval of three to four weeks had been allowed between the partial and the total closure of the internal carotid artery. The advent of facial weakness on the contralateral side from a small extradural hemorrhage necessitated reopening the wound, and for that reason it was reluctantly determined to close the carotid at the same time (the Matas test then indicating that the circulation was adequate).

COMMENT

In a recent review of 108 arterial aneurysms of the brain that came to operation or necropsy, 9 (8.3 per cent) were in the carotid canal; in 1 case the condition was bilateral (fig. 4). From the literature, 27 additional cases have been collected, in 3 of which the condition was

Author	Date	How Proved	Size	Unilateral or Bilateral	Patient		Duration of Symptoms	Headache	Pain	Paralysis of Third Nerve	Visual Loss
					Age, Yr.	Sex					
Blane	1800	Necropsy	.....	Bilateral and symmetric	..	..	.....	.....	.....	.....	.....
Holmes	1861	Necropsy	Size of a small nut	Unilateral	16	M	3 mo.	General	Over the left eye	Complete	Blind on affected side
Adams	1860	Necropsy	Size of a walnut	Unilateral	56	M	5 mo.	.....	Right temporal	Complete	Blind on affected side
Romberg	1853	Necropsy	Double normal size of carotid	Unilateral	57	M	10 yr.	.....	Facial neuralgia	None	None
Hutchinson	1875	Necropsy	Size of a bantam's egg	Unilateral	50	F	11 yr.	Periodic	Throbbing temple	Partial; later, complete	None
Bramwell	1886	Necropsy	3 in. (7.6 cm.)	Unilateral	31	M	6 yr.	.....	.....	.....	Bitemporal hemianopia
Dempsey	1886	Necropsy	¾ in. (1.9 cm.) in diameter	Unilateral	22	F	.....	None	+ From ophthalmic aneurysm	None	.....
Czermak	1902	Necropsy	5.5 cm.	Unilateral	..	..	8 yr.	.....	.....	Complete	.....
Czermak	1902	Necropsy	Size of a mandarin	Unilateral	61	M	8 yr.	+ Right frontal	.....	Complete	Blind on affected side from keratitis
Reinhardt	1913	Necropsy	4.5 by 4 cm.	Unilateral	41	M	9 yr.	Severe	In the left part of the forehead and the left eye	Complete	Blind on affected side
Nettleship (reported by Beadles)	1907 (1889)	Necropsy	4 cm.	Unilateral	61	F	10 yr.	.....	In the nose	Complete	Blind in one eye
Heuer and Dandy (case 1)	1916	Necropsy	3.5 by 2 by 2 cm. and 8 by 7 by 7 cm.	Bilateral	29	M	5 yr.	Violent	In the left eye and the head	Complete	Blind in the left eye; temporal hemianopia on the right
Cushing (reported by Viets)	1918	Operation; decompression	Size of a walnut	Unilateral	26	F	7 wk.	+	Sudden in the right side of the head	Complete	None
Magnus	1927	Operation	Size of a chestnut	Unilateral	69	M	3 mo.	None	Constant facial neuralgia	None	None
Bozzoli	1937	Necropsy	Large	Bilateral	59	M	3 mo. (following trauma ?)	None	.....	None	Visual acuity 1/10 for the left eye; 2/10 the right
Jefferson	1937	Operation	Very large in drawing	Unilateral	50	F	5 yr.	Dull left sided	.....	Complete	Visual acuity, 6/
Robinson (reported by Beadles)	1937	Necropsy	1 inch (2.5 cm.) diameter	Unilateral	..	..	.....	.....	None	None	None
Fincher	1938	Colloidal thorium dioxide	Small	Unilateral	35	M	5 mo.	+ Vertical	+	Complete	None
Jefferson (case 1)	1938	Operation for trigeminal neuralgia	Large	Unilateral	65	F	18 yr.	+	Constant trigeminal neuralgia and pain in the head	None	None

Visual Loss	Exophthalmos	Other Signs and Symptoms	Intracranial Pressure	Diagnosed Correctly	Treatment	Result	Rupture	Comments
.....	.....	.....	None	No	.....	.....	.....	
Blind on affected side	.....	Giddiness	None	No	None	Dead	No	Partly filled with clot; center open; thought to be due to endocarditis
Blind on affected side	.....	Giddiness; cornea ulcerated	None	No	None	Dead	No	Partly filled with clot; center open
None	.....	Giddiness	.....	No	None	Dead	No	Patient had only trigeminal neuralgia
None	.....	"Beating under the ears"	Probably	Yes	None, but it was proposed to ligate the carotid	Dead	No	Aneurysm removed and preserved in the museum of the Royal College of Surgeons; thought to be solid; calcified walls
Bitemporal hemianopia	.....	.....	Probably	No	None	Dead	No	Protruded into cranial cavity
.....	+ From ophthalmic aneurysm	Principal symptoms from ophthalmic aneurysm	None	No	Common carotid tied	Dead	No	Patient had intracranial carotid aneurysm and one of the ophthalmic artery also
.....	.....	.....	Present	No	None	Dead	Yes	
Blind on affected side from keratitis	None	Syphilis; keratitis first symptom	Probably	No	None	Dead	+	Abducens palsy 6 yr. before advent of third nerve change
Blind on affected side	+	.....	Present	No tumor diagnosed	None	Dead	No	Photograph of enormous aneurysm; much of the aneurysm filled with firm clot
Blind in one eye	+	Exophthalmos; bleeding from nose repeatedly	Present	No	None; ligation suggested	Dead	Yes; into the nose	Another small aneurysm was in the neck; patient died of nasal hemorrhage; specimen in museum
Blind in the left eye; temporal hemianopia on the right	+	.....	Marked	No; but suggested as a possibility by Dr. H. M. Thomas	None (decompression)	Dead	No	Marked long linear shadows in the brain; destruction of sella (first case with roentgen changes)
None	None	Discomfort in the neck; dizziness; vomiting	Present	No	None	Died 1 yr. later	?	Died suddenly; no autopsy
None	.....	.....	None	At operation for trigeminal neuralgia	Internal carotid ligated in the neck	.....	.....	Encountered and opened during operation for tic douloureux (temporal route)
Visual acuity 1/10 for the left eye; 2/10 for the right eye	None	Syphilis; calcification alongside the sella	None	No	None	Dead	No	
Visual acuity, 6/60	+	Weakness on the right side of the body; erosion of the wing of the sphenoid; faint roentgen shadow; the sella not eroded	Present	No	None	Dead	No	Patient died 8 wk. later following increase in hemiplegia; "almost completely" thrombosed
None	.....	None	None	No	None	Dead	No	Recorded in museum; Beadles stated that there was no clinical evidence of the existence of an aneurysm
None	.....	.....	None	Yes	Clipping carotid intracranially after tying in neck	Well	No	
None	None	Calcification developed in aneurysm; several years later there was periodic bleeding from the nose; blood pressure, 175/100	None	No	None	Died 14 yr. later	.....	Began with sudden severe pain in the head; vomiting; coma for 2 or 3 days

Author	Date	How Proved	Size	Unilateral or Bilateral	Patient		Duration of Symptoms	Headache	Pain	Paralysis of Third Nerve	Visual Loss
					Age, Yr.	Sex					
Jefferson..... (case 3)	1938	Operation	Large	Unilateral	61	F	20 yr. (headache)	+	.....	Complete	None
Jefferson..... (case 8)	1938	Operation	Small	Unilateral	61	F	3 mo.	+ Right frontal	+ Behind the right eye	Complete	
Jefferson..... (case 16)	1938	Necropsy	Large	Bilateral	72	F	1 mo.	+ Left	Trigeminal	Incomplete on the left	
Sands and Hyman	1938	Necropsy	4.5 by 4 by 3.5 cm.	Unilateral	24	F	10 yr.	Present at end	.....	.....	None
Dandy (case 2)...	1939	Operation	Small	Unilateral	28	F	5 mo.	+ Left frontal	In the left eye	Complete	Vision reduced on the affected side
Dandy (case 3)...	1939	Operation	Small	Unilateral	36	M	8 mo.	+ Left frontal	In the left eye	Partial	None
Dandy (case 4)...	1939	Operation	Small	Unilateral	37	F	5 yr.	+ Right frontal	In the right eye	Complete	
Reichert.....	1938	Colloidal thorium dioxide	Large	Unilateral	50	M	9 yr.	+ Present 2 to 3 yr.	+ In the right part of the forehead	Complete	
Dandy (case 5)...	1941	Necropsy	Size of a hazelnut	Unilateral (2 lesions)	53	M	None from arterial aneurysm until rupture	.....	.....	.....	Not from arterial aneurysm
Kosic.....	1941	Colloidal thorium dioxide	Small	Unilateral	42	F	3 wk.	.....	.....	Complete	None
Krayenbühl.....	1941	Colloidal thorium dioxide	4 by 3.5 cm.	Unilateral	21	F	8 mo.	+	Severe in the left part of the forehead	None	None
Krayenbühl.....	1941	Operation (colloidal thorium dioxide negative)	Walnut size	Unilateral	44	M	18 mo.	+	+ In the left eye and the left part of the forehead	Complete	Blind on affected side
Werner, Blakemore and King	1941	By wiring (roentgenograms)	Very large	Unilateral	17	F	6 yr.	Generalized and severe	In the right eye and temple	None	Eventually blind
Dandy (case 6)...	1942	Operation	Small	Unilateral	24	M	22 yr.	+ Left frontal	In the left eye	Complete	Visual acuity 10/400 for left eye 20/15 for the right
Dandy (case 7)...	1942	Operation	Small	Unilateral	20	M	3 mo.	+ Right frontal	In the right eye	Complete	None
Dandy (case 8)...	1942	Operation	Huge	Unilateral	52	F	4 yr.	+ Right frontal	In the right cheek	Complete	Visual acuity, 20/50 for right eye and 20/ for the

Reported in the Literature—Continued

	Visual Loss	Exophthalmos	Other Signs and Symptoms	Intracranial Pressure	Diagnosed Correctly	Treatment	Result	Rupture	Comments
nches	None	.....	Began with sudden terrific pain in the left temple; diplopia for a few days (3 yr. earlier); blood pressure, 135/90	?	Yes	None	Living 5 yr. later	No	Exposed through decompression
branch	None	None	Erosion of the sella	None	Yes	None	Living 6 yr. later	No	
algesia whole ide	Loss to visual acuity of 2/24 in each eye	None	Erosion of the sella	None	Yes	None	Dead	No	Patient died of coronary occlusion; the left aneurysm was five or six times as large as the right
hesia cornea	None	.....	Double vision; convulsions; attacks of mental confusion	Present	No	None	Dead	Yes	Projected into the brain
	Vision reduced on the affected side	None	.....	None	Yes	Internal carotid ligated intracranially in the neck	Living 5 yr.	+	Aneurysm broke through the dura; small protrusion intracranially alongside the carotid
ng tion neck	Blurring in the left eye; visual acuity 20/30 for the left eye and 20/120 for the right	None	.....	None	Yes	Aneurysm trapped between ligatures	Living 3½ yr.	No	Aneurysm broke through dura alongside the intracranial part of the carotid
	Visual acuity 20/50 for the right eye and 20/25 for the left	None	.....	None	Yes	Aneurysm trapped between ligatures	Living 3½ yr.	Probably	Aneurysm broke through dura alongside the intracranial part of the carotid
	Visual acuity 5/10; small central scotoma	+	Noise in the ear on the same side; no pulsation in exophthalmus; papilledema	?	Yes	Partial ligation of the carotid with fascia	Well	No	Improvement after operation (3 weeks)
.....	Not from arterial aneurysm	+ Not from arterial aneurysm	All signs of pulsating exophthalmos	None	No	Attempted closure of internal carotid	Dead	No	Operation for carotid-cavernous arteriovenous aneurysm; cause found at necropsy to be rupture of two small arterial aneurysms; artery tore, death resulting
	None	None	.....	None	Yes	None	Living	No	
	None	+	Some erosion of the sella; double vision first symptom	None	Yes	Ligation of the carotid	Well	No	Two years later strabismus gone and the patient felt well
and d hes	Blind on affected side	+	.....	None	Yes	Ligation of the carotid	Well	No	Three weeks after operation extraocular palsies much improved and anesthesia of the face reduced
res- of all hes	Eventually blind	+ 5 mo.	Bruit heard; erosion of the sella, the orbit and the sphenoid; Simmonds' disease; amenorrhea	Probably	Yes	Wiring (30 ft. [914.4 cm.]); both common carotids tied	Living 29 mo.	No	
	Visual acuity 10/400 for the left eye and 20/15 for the right	None	Small dense calcification in the cavernous sinus	None	Yes	Aneurysm trapped between ligatures	Living 2¾ yr.	Probably	Third nerve palsy persisted since age of 2 yr.; aneurysm confined to sinus
	None	None	.....	None	Yes	Aneurysm trapped between ligatures	Living 3¾ yr.	Probably (bloody spinal fluid)	Large nut-sized aneurysm broke through dura alongside the carotid
anches tial)	Visual acutiy, 20/50 for the right eye and 20/20 for the left	+ 4 mm.	The sella destroyed; central scotoma on the right	Present	Yes	Aneurysm trapped between ligatures after partial ligation in the neck	Living 2 mo.	No	One of the enormous aneurysms pushing far upward into the temporal lobe

bilateral. The total number of cases therefore is 35, and the total number of aneurysms, 39. The 4 bilateral cases in the literature were reported by Blane (1800), Heuer and Dandy (1916), Jefferson (1938) and Bozzoli (1937). When bilateral, aneurysms may be symmetric (Blane), nearly symmetric (Bozzoli) or markedly asymmetric (Heuer and Dandy, Jefferson).

Jefferson (1938), in an excellent paper, reported 17 cases, but only 6 of these (including 2 in 1 patient) were authenticated; the remainder were assumed to be cases of aneurysm in the carotid canal because of signs and symptoms. But important as are the subjective and objective disturbances, they are by no means pathognomonic either of aneurysms or of the exact location of the lesion, i. e., whether in the carotid canal or intracranial. Two of Jefferson's aneurysms diagnosed by angiograms were clearly intracranial because they extended to the circle of Willis.

There are three methods by which the aneurysm and its exact position can be determined: (1) by necropsy; (2) by operation, and (3) by angiograms. A fourth method should probably be included, viz., roentgenograms of wire inserted into the aneurysm (Werner, Blakemore and King's case). There may be occasional calcifications which are adequately demonstrated by roentgen examination, but in most cases, even with the knowledge that calcifications are present, one is still left in doubt whether the lesion is a tumor or an aneurysm. For example, it is possible that 2 of the aneurysms reported by McKinney, Acree and Soltz may have been in the carotid canal, but no differentiation was made between these two subdivisions of the carotid, and it is impossible to make the determination from their roentgenograms; moreover, the writers placed them in the cranial chamber. The first description of the curved linear intracranial roentgen shadows that are almost pathognomonic of the calcified walls of aneurysms was reported by Heuer and myself in 1916 (case 1, fig. 5). Although neither Heuer nor I was aware of their significance at the time, their import was recognized by Dr. H. M. Thomas, then professor of neurology at the Johns Hopkins University School of Medicine, and the suggestion of an aneurysm was made by him and is so recorded in the history. Shadows of similar character are shown in the plates presented by Sosman and Vogt (1926) and McKinney, Acree and Soltz (1936). In 1 other case (case 6) in my series, a small dense irregular calcification in the carotid canal could leave no doubt concerning the diagnosis, especially when connected with the history. In Bozzoli's case, bilateral shadows alongside the sella turcica were of similar character.

Since the advent of angiography by Egas Moniz in 1933, intra-arterial injections of colloidal thorium dioxide have demonstrated many intracranial aneurysms. Beautiful examples of those in the carotid canal have been reported by Fincher (1938), Reichert (1939), Krayenbühl

(1941) and Kosic (1941). A second aneurysm of Krayenbühl failed to show in an arteriogram and was disclosed at operation. The demonstrations of aneurysms of this type at operation have been made by Cushing (1918—reported by Viets), Magnus (1927), Jefferson (1938) —4 cases—and me—6 cases. There can be no uncertainty about the diagnosis at operation, for the aneurysms pulsate, and blood can be aspirated from them if there is any doubt. Magnus opened an aneurysm while operating for trigeminal neuralgia, but the patient survived after the aneurysm had been packed and the internal carotid artery ligated in the neck. Cushing exposed one through a decompression opening. In 1 of

Fig. 5.—Calcifications in the aneurysms shown in figure 4. Note their linear character and one whorl: also, destruction of the sella turcica.

Jefferson's cases, the aneurysm was exposed during a trigeminal operation, and the patient lived fourteen years. In his other 3 cases, the aneurysms were found when the clinically localized lesions were explored. In all of my 6 operative cases, the patients were operated on with the impression that the lesions were aneurysms and with surgical attack in mind.

Aneurysms in the carotid canal vary in size, like those located intracranially, from the so-called small berry aneurysm to those the size of an orange. Some are localized projections from the wall of the artery; others are dilatations of the whole arterial trunk.

According to signs and symptoms, aneurysms of the carotid canal fall into three types: (1) those giving palsies of the extraocular muscles; (2) those giving trigeminal neuralgia and corresponding sensory loss, and (3) those in which types 1 and 2 are combined. By far the most important manifestations of an aneurysm in this region are palsy or paralysis of the third nerve and periodic severe pain in the affected eye or frontal region. These disturbances are equally present with intracranial aneurysms of the internal carotid or even of the posterior communicating artery. But when to this pain and paralysis is added involvement, whether subjective or objective or both, of the first and second branches of the trigeminal nerve (eventually of all three branches), the diagnosis of an aneurysm, and that one in the carotid canal, is almost absolute. Usually paralysis of the fourth and sixth nerves coexist. In Czermak's case palsy of the abducens antedated that of the third nerve by six years (in his case anesthesia of the cornea [fifth cranial nerve] also antedated involvement of the third nerve by the same time). Dural tumors of the lesser wing of the sphenoid and neuritis of the third nerve also may give identical objective findings, but with both of these conditions the severe attacks of pain in the eye and the frontal region are absent. Pain of this character and location has been perhaps the most consistent subjective complaint in all of the recorded cases. A sudden severe pain is always suggestive of vascular expansion or rupture.

Since these aneurysms lie on the gasserian ganglion, it is expected that trigeminal neuralgia, probably more or less continuous, and eventually sensory loss should be present. Actually, however, in 10 cases these subjective and objective disturbances were absent or not noted. Their absence therefore does not militate against the diagnosis of an aneurysm in the carotid canal, but their presence is all important. Romberg's (1853) patient, who had 1 of the smallest aneurysms reported, had only facial neuralgia; the patients of Magnus (1927) and Jefferson (1937) had this type of neuralgia plus palsy of the abducens. Jefferson proposed subdivision of aneurysms in the carotid canal into three further types: (1) posterior; (2) middle, and (3) anterior, i. e., corresponding with the three positions of the lesion in the carotid canal. Under the posterior type of aneurysm he placed those with involvement of all three branches of the trigeminus and palsies of all the extraocular muscles. With the middle type the third branch of the trigeminus is spared, and with the anterior type only the first branch of the trigeminus is involved. However, there appears to be little point in this finer classification. The greatest involvement of nerves is more an index of the size of the aneurysm.

Loss of vision is an important and common subjective and objective disturbance. It is of course due to direct pressure of the bulging aneurysm on the optic nerve or on the nerve through the interposed carotid artery as in 1 of my cases (case 8) in which there was only a

central scotoma. Eventually there may be blindness in the eye on the affected side. Occasionally, as in 1 of my cases, the aneurysm may enlarge sufficiently to attack the optic chiasm and produce hemianopia in the other eye. When one sees the enormous size of many of these aneurysms, it is surprising that vision is retained so long. It is the tightly attached dura at the anterior part of the middle fossa that protects the actual contact with the optic nerve until the size of the aneurysm grows excessive and finally compresses it.

At times papilledema results from intracranial pressure as the aneurysm grows upward into the cranial chamber. Both eyegrounds may be similarly affected, or there may be primary optic atrophy on the affected side and papilledema on the other side.

The very nature of aneurysms, i. e., their being due to defective arterial walls, predisposes them to rupture, and since a high percentage—at least 75 per cent—are of congenital origin, frequently the rupture occurs in the early years of life. Aneurysms in the carotid canal are less susceptible to rupture than those within the cranial chamber because they are covered by the firm layer of dura which expands slowly. This accounts for the long duration of symptoms in so many instances. However, they are by no means immune to this termination. Four deaths resulted in this collected series from this cause—the rupture taking place into the cranial chamber. In 3 of my operative cases, the rupture had probably occurred alongside the carotid (from small intracranial extensions), and the point of rupture had healed owing to the contact with the carotid artery. In 1 of my cases (case 2) two separate small aneurysms had ruptured into the cavernous sinus and produced an arteriovenous aneurysm (pulsating exophthalmos). This is one of the important causes of this remarkable lesion; it may occur spontaneously or be induced by trauma. In this case the existence of the arterial aneurysm as the underlying cause was recognized only at necropsy. In Nettleship's case repeated ruptures had occurred into the nose, death finally resulting.

Exophthalmos was noted in 9 cases, including the case reported here. This can occur only with the large aneurysms which have eroded the walls of the sphenoid fissure and have therefore broken through into the orbit. Pulsation of the eyeball was noted but rarely in spite of the violent pulsation of these aneurysms; doubtless it was missed in some instances. Dempsey's case is noteworthy because in it there was an aneurysm of the ophthalmic artery in addition to the diffuse enlargement of the internal carotid artery (¾ inch [1.9 cm.]) in the canal.

Bruit was noted only in the case reported by Werner, Blakemore and King. Hutchinson was skeptical of reports of bruits with intracranial aneurysms and concluded that a bruit was present only with the arteriovenous variety—then termed aneurysm by anastomosis. In none of my

cases was a bruit detected. It does occur, but only rarely, and is hardly worthy of consideration in differential diagnosis.

That a spontaneous cure of an aneurysm of this type ever occurs is doubtful, though perhaps possible. Frequently the aneurysm is partially filled with a firm old thrombus that is laid down in layers. Hutchinson noted that the aneurysm in his case was "almost entirely" filled with thrombus; however, the specimen was not opened, and his deduction was made by probing. Jefferson stated that 1 of his large aneurysms was "almost completely" thrombosed. Many aneurysms are indeed almost completely filled with thrombus, but a central channel is usually patent and is in communication with the lumen of the artery, and they still remain active aneurysms. In 1 of Krayenbühl's cases, the internal carotid and the middle cerebral arteries were completely thrombosed (hemiplegia resulting). It appears probable that this may have been a case of complete thrombosis and cure of the aneurysm, but the patient survived, and no pathologic report was therefore in evidence.

The ages of patients at the time of operation, death or disclosure of the aneurysm run fairly evenly according to decades. Only 2 were under 20, although several of those in the succeeding decade had their origin before 20. In 1 of my cases (case 6), the aneurysm ruptured at the age of 2 years. Eight aneurysms occurred in the third and sixth decades; 6, in the seventh; 4, in the fourth; and 3, in the fifth. The oldest patient was 72 (Jefferson). Sixteen patients were male and 16 female. Twenty of the aneurysms were of the large type that protrudes upward into the cerebral chamber; many of these caused intracranial pressure.

The duration of symptoms varies considerably; 18 patients (over 50 per cent) had symptoms over three years; 9 had symptoms nine years or more; 3 lived eighteen, twenty and twenty-two years, and at the time of writing, 1 (case 6) is still living after twenty-five years. In several cases, however, the course was more fulminating, lasting a few weeks or months.

The fact that 13 of these aneurysms were actually disclosed at operation testifies to the great progress in neurosurgery in recent years. A few were accidental disclosures, 2 (Magnus and Jefferson) being found during operation for trigeminal neuralgia by the temporal route. Magnus had the terrifying experience of opening the aneurysm but was able to pack the opening and tie the internal carotid artery in the neck. Despite the advanced age of the patient (69 years), the ligation caused no ill effects. The extradural approach to the gasserian ganglion of course reduces the hazards of a ruptured aneurysm in this position.

The disclosure of aneurysms by angiography has attained a great vogue since its introduction by Egas Moniz, and viewed superficially, the results appear to be remarkable. Certainly the roentgenograms depict the lesion beautifully both in diagnosis and localization, but from a

practical point of view, I consider its use inadvisable. It is not a procedure without risk. Cerebral thromboses were reported by Ekström and Lindgren in 60 per cent of the brains examined after death. These may or may not cause symptoms at the time, but they certainly are a potential cause of epilepsy. Moreover, the colloidal thorium dioxide is a permanent deposit in the reticuloendothelial system. There is no reason to inject it when the signs and symptoms clearly indicate the site of a lesion which should be exposed at operation. This statement holds true for all aneurysms in the carotid canal, where the localizing disturbances are so pathognomonic of the site of the lesion and clinical judgment is almost adequate to identify the character of the lesion. If it was a matter of diagnosing a hopeless type of lesion and thus avoiding an operation, it might be a procedure of merit, but all the aneurysms in this group are operable and should be operated on. In 1 of Krayenbühl's cases, the angiogram did not disclose the lesion which was subsequently found at operation. Patients are certainly better without it!

Of the 7 patients operated on there was 1 who died—a mortality rate of 14 per cent. The death occurred in a case in which operation was done for a carotid-cavernous arteriovenous aneurysm, and at necropsy the cause of the arteriovenous aneurysm was found to be rupture of two small arterial aneurysms in the carotid canal. Death was due to rupture of an oversized arteriosclerotic artery during the application of a silver clip that was too small. In over 20 closures of the carotid intracranially by this method, this was the only accident. The other 6 patients were cured, the longest period after operation being three and one-half years.

SUMMARY

The case of a presumably cured patient with a large aneurysm of the internal carotid artery arising in the carotid canal and extending into the cranial chamber is presented.

The differential diagnostic signs and symptoms are emphasized.

The surgical attack previously employed for the smaller aneurysms, viz., trapping the aneurysm by ligating the internal carotid artery intracranially and in the neck, was applied with equal success to 1 of enormous size after forcing adequate collateral circulation through the circle of Willis by preliminary partial ligation of the internal carotid in the neck.

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SURGICAL SIGNIFICANCE OF EPIPLOIC APPENDAGES

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Epiploic appendages are flattened projections of serosa-enclosed fat found along the colon from the cecum to the lower portion of the sigmoid, attached chiefly along the anterior taenia coli. Their size varies from a few millimeters to several centimeters. Blood is supplied by means of a single circular artery and vein, forming an arcade which extends into the tag. These appendages are present after the fifth to the seventh fetal month, although they are often overlooked if the patient is young or thin. Their function is not definitely known. It is likely that they act as a depot for fat, as a protective mechanism in peritoneal infection and as a cushion to the colon and its increasingly more solid contents.

It is generally acknowledged that epiploic appendages frequently undergo torsion, infarction and calcification; that they often produce symptoms closely simulating abdominal conditions requiring operation is appreciated less widely, and that they occasionally initiate pathologic states incompatible with health or even life is generally overlooked. We recently reviewed the instances of pathologic epiploic appendages reported in the literature and those encountered at the Mayo Clinic over a period of thirty-five years. We wish to summarize those cases in which symptoms definitely related to the appendages were present and to stress the significance of diseased epiploic appendages as a factor in acute and chronic abdominal conditions.

The pathologic conditions encountered included torsion, thrombosis and infarction; cystic, hyaline or calcareous degeneration; simple necrosis; gangrene; inflammation; hyperplasia and secondary carcinomatous implantation. Torsion undoubtedly initiates the great bulk of pathologic changes, but not all abnormalities of the epiploic tags should be classified under this heading. The general insistence on this term in the literature is misleading. In our series of cases, although torsion fre-

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quently could be assumed, actual twisting of the pedicle was not often demonstrable.

From the clinical standpoint, a practical classification of abnormal epiploic appendages would segregate the intra-abdominal from the hernial appendages and the free from the attached appendages. But this form of classification would chiefly distinguish between the symptomatic group and the asymptomatic or incidental group. We have employed such a method of classification. Both groups are separated into those appendages involved by primary pathologic processes and those secondarily involved. Our classification is as follows:

A. Symptomatic conditions (of intra-abdominal appendages):
   1. Primary disease of an appendage
   2. Secondary involvement of an appendage
B. Asymptomatic or incidental conditions
   1. Of intra-abdominal appendages
      a. Primary involvement of an appendage
      b. Secondary involvement of an appendage
      c. Free or detached appendages
   2. Of intrahernial appendages

REVIEW OF THE LITERATURE

Epiploic appendages were first described in 1543 by Vesalius.[1] Littré,[2] in 1703, reported finding an epiploic appendage as a free foreign body in the peritoneal cavity of a cadaver. Similar findings were reported at later dates by Virchow,[3] Cruveilhier[4] and Laveran.[5] Hunt[6] placed Tomellini's case first in his review of cases of intra-abdominal torsion reported in the literature. Tomellini[7] demonstrated at necropsy in a case in which cardiac paralysis had caused death an epiploic appendage with a pedicle which had undergone true torsion around its long axis.

Analysis of the literature reveals that interest has been mounting in recent years on the subject of intra-abdominal torsion of epiploic appendages. To date, however, true symptomatic intra-abdominal torsion rarely has been diagnosed preoperatively. In fact, the only report of a

1. Vesalius, A., cited by Harrigan, A.: Torsion and Inflammation of the Appendices Epiploicae, Ann. Surg. **66**:467-478, 1917.

2. Littré, cited by Davis.

3. Virchow, R., cited by Hunt.[6]

4. Cruveilhier, J., cited by Hunt.[6]

5. Laveran, cited by Hunt.[6]

6. Hunt, V. C.: Torsion of Appendices Epiploicae, Ann. Surg. **69**:31-46 (Jan.) 1919.

7. Tomellini, cited by Hunt.[6]

case in which the diagnosis was made before operation was reported by Babcock.[8] Insidious in character, diseased epiploic appendages can produce symptoms which simulate appendicitis, cholecystic disease, intestinal obstruction and other abdominal conditions.

Of the cases of intra-abdominal torsion of epiploic appendages collected from the literature by Hunt and of those reported by him, in 12, symptoms and conditions requiring operation were present which caused divergent preoperative diagnoses to be made as follows: appendicitis in 3, appendicitis and cholecystitis in 2 and, in 1 case each, diverticulitis, intestinal paralysis, tumor of the sigmoid, intestinal obstruction and disease of the left fallopian tube and ovary. In 2 of the 12 cases, diagnosis was not made; the only pathologic finding to explain the symptoms in these cases was torsion of the epiploic appendages.

Of the cases reviewed by Fiske[9] in 1936, in 21, the condition was symptomatic, and intra-abdominal torsion, infarction or inflammation was the only lesion discovered at operation. The preoperative diagnosis had been appendicitis in 10, torsion of an ovarian cyst in 3 and, in 1 each, torsion of an epiploic appendage, diverticulitis and Meckel's diverticulum. Diagnosis was not made in 5 cases.

Pines and associates[10] recently reported 7 cases of intra-abdominal torsion and hemorrhagic infarction of epiploic appendages. A preoperative diagnosis of appendicitis was made in 4 instances and, in 1 case each, diverticulitis, sigmoiditis with perforation and abscess of the abdominal wall. At operation, torsion of the epiploic appendages was found in 4 cases, and in 3, infarction was the only lesion found.

Nine cases of symptomatic primary lesions of epiploic appendages have been collected from the literature in addition to those mentioned, bringing the total to 49. Abstracts of the 9 cases are included in table 1.

Of the 49 cases reviewed in which symptoms were present, in 39 acute abdominal symptoms were present at the time of operation. In 10 of these 39 cases, a history of chronic symptoms also was present; in the 10 remaining cases, the symptoms of abdominal pain were chronic. Abdominal pain was a constant feature in all cases, and the location of the pain usually depended on the site of the lesion. The pain was situated in the left lower quadrant of the abdomen in 22 cases, in the right lower quadrant in 17 and in the epigastrium in 3. In 2 cases each, the pain was located in the abdomen as follows: generalized; in the right

8. Babcock, W. W., cited by Fiske.[9]

9. Fiske, F. A.: Intra-Abdominal Torsion of Appendices Epiploicae, with Report of Two Cases and Review of Literature, Am. J. M. Sc. **192**:354-360 (Sept.) 1936.

10. Pines, B.; Rabinowitch, J., and Beller, S. B.: Primary Torsion and Infarction of the Appendices Epiploicae, Arch. Surg. **42**:775-787 (April) 1941.

TABLE 1.—*Additional Cases of Symptomatic Epiploic Appendages from the Literature*

Author	Patient		Abdominal Pain		Nausea and Vomiting	Tenderness and Rigidity	Palpable Tumor	Leukocytes	Preoperative Diagnosis	Site of Lesion	Comment
	Age	Sex	Location	Duration							
Campbell, H. E.: Chinese M. J. **51**: 357-360, 1937	46	M	Left lower quadrant	2 days	Absent	Present	No	13,000	Strangulated hernia	Sigmoid	Mass of fatty tissue, 5 by 3 cm.
Piulachs, P.: Ann. d'anat. path. **15**: 207-209, 1938	18	F	Right lower quadrant	2 days	Present	Present	No	.....	Acute appendicitis	Cecum	Normal appendix
Micheli, P. L.: Arch. ital. di chir. **53**: 80-87, 1938	25	F	Left lower quadrant	12 days	Absent	Present	No	.....	Abdominal colic	Sigmoid	Gradual onset of generalized pain, finally localizing
Davis, B. F.: Minnesota Med. **22**: 151-153, 1939	35	M	Left lower quadrant	Few hours	Present	Present	No	18,600	Acute diverticulitis	Sigmoid	Torsion of the pedicle; intense passive congestion
Eliason, E. L., and Johnson, J.: Surgery **6**: 68-73, 1939	47	F	Right upper quadrant	7 days	Absent	Present	No	12,300	Acute cholecystitis	.....	Inflamed epiploic appendage
	38	M	Left lower quadrant	4 days	Absent	Present	Yes	.....	Acute epiploitis	.....	Pain and tenderness well localized
	40	M	Left lower quadrant	3 days	Present	Present	Yes	.....	Diverticulitis	.....	Inflamed epiploic appendage
Porier, A.: Bull. et mém. Soc. d'électro-radiol. méd. de France **27**: 184-188, 1939	57	M	Generalized	3 mo.	Nausea and constipation	Tenderness	....	.....	.....	Cecum	Periodic attacks of sharp generalized abdominal pain
Walker, H. C.: Am. J. Obst. & Gynec. **37**: 811-818, 1939	32	F	Left lower quadrant	3 days	Nausea only	Soreness	Yes	13,800	Twisted ovarian cyst	.....	Pain aggravated by movement; 7 months' pregnancy; tender soft mass along the inguinal region

upper quadrant; in the lower portion of the abdomen. In 1 case, the pain was in the rectum. Nausea and vomiting were present in 12 cases, and nausea alone was present in 6. Tenderness and rigidity at the site of the lesion were found in 21 cases, and tenderness alone was found in 14. A mass was palpated in 7 instances. Fever was present in 1 case and leukocytosis in 2.

A preoperative diagnosis of appendicitis was made in 18 instances and no diagnosis in 8. Diverticulitis was the diagnosis in 5 cases, torsion of an ovarian cyst in 4 and appendicitis and cholecystitis in 2. In 1 case each, the following preoperative diagnoses were made: acute cholecystitis, abdominal colic, ovarian disease, intestinal obstruction, intestinal paralysis, Meckel's diverticulum, sigmoiditis with perforation, strangulated hernia, abscess of the abdominal wall, tumor of the sigmoid, acute epiploitis and torsion of an epiploic appendage.

Torsion of the epiploic appendages was the only lesion found and was responsible for abdominal symptoms in 41 cases; infarcted epiploic appendages and inflamed epiploic appendages were found in 4 cases each.

Of the cases reviewed by Hunt, postoperative death occurred in 2 cases; in those reviewed by Fiske 1 death occurred.

CASES ENCOUNTERED AT THE MAYO CLINIC

Since the report of Hunt in 1919, abnormalities of epiploic appendages have been noted at the Mayo Clinic in 178 cases encountered from 1919 to April 1941. Although this number is large, it is not presumed that this is the total number of cases in which diseased tags were present since not all incidental or free tags are found on exploration or are reported when observed. In 18 instances, the tags were intrahernial, leaving 160 cases in which the pathologic processes were intra-abdominal. In 53 of these, the tags were free in the peritoneal cavity. In 1 of the 18 cases, the intrahernial tag also was unattached. In the cases in which the tags were intra-abdominal, 61 tags were considered to reveal evidence of primary involvement of the epiploic appendage, excluding the unattached tags, while in 46, the intra-abdominal tags were considered definitely or probably secondary to other pathologic processes of the abdomen. These related conditions included appendicitis, inflammation of Meckel's diverticulum, pelvic inflammation and tumor, endometriosis, cholecystic disease, peptic ulcer and carcinoma of the large bowel.

The circumstances under which abnormal tags were found incidental to operation for other conditions cover a wide range. Tags were found at operation for conditions in the upper portion of the abdomen in 29 cases and in 120 cases in which operation was performed on the lower portion of the abdomen. In 7 of these 120 cases, operation was performed by the vaginal route.

The pathologic conditions exhibited by the tags reviewed are listed in order of frequency as follows: necrosis, degeneration or gangrene, recorded in 65 cases; calcification, in 39; inflammation, in 31; torsion, in 18; hemorrhagic infiltration, in 14; hyperplasia, in 3; cystic change, in 2; hyalinization, in 1; carcinomatous implantation, in 1. In some instances more than one pathologic condition was present in the same tag. It should be noted that torsion was proved in only 18 cases—in 15 as an incidental finding and in 3 cases in the symptomatic group.

Symptomatic Conditions.—We are primarily concerned, from the clinical standpoint, with those cases in which definite symptoms were present. In the present series, there were 10 cases in which diseased epiploic appendages produced symptoms necessitating operative intervention (table 2). In the cases of hernial appendages and in the cases in which the tags were free, instances of definite symptoms could not be substantiated.

Of the cases in which symptoms were present, in 5, appendicitis was simulated and in 1 case each, appendicitis or cholecystitis, pelvic inflammation, carcinoma of the sigmoid, malignant disease in the upper portion of the abdomen and intestinal obstruction. The symptoms presented were reviewed in an effort to determine any factor or factors aiding in the diagnosis of diseased epiploic appendages. Ages of the patients ranged from 19 to 69 years. The ratio of men to women was 6:4. Symptoms were acute or subacute in 4 cases and chronic in 6. The most consistent complaint was pain, which was present in all but the 1 case of chronic obstruction. The pain tended to be mild and constant in 5 cases, but in 4 it was severe and recurrent. Contrary to what is found with typical appendicitis, there was rarely a primary epigastric component with secondary extension and localization of pain. Although nausea and vomiting are considered unusual, they were present in 2 cases in which obstruction was absent.

On examination, localized abdominal tenderness was the chief finding in 7 cases of this series, being acute in only 2. Rebound tenderness was noted in 2 cases and increased muscle tone in 1. In 4 instances, a mass was found in the abdomen or in the pelvis. Rectal examination was of little value, although in 1 case it revealed pelvic appendicitis. The temperature was slightly elevated from 99 to 99.4 F. in 3 cases. In only 2 cases did a leukocyte count of more than 10,000 per cubic millimeter of blood tend to indicate the presence of an inflammatory process.

At operation, the typical finding, instead of the preoperatively diagnosed conditions, was a swollen blue-black or hemorrhagic epiploic tag, generally attached in the sigmoid or the cecal region, which on removal disclosed various degrees of degeneration, gangrene, inflammation or hemorrhage. Torsion was proved in only 3 cases in which symptoms

TABLE 2.—*Cases of Symptomatic Epiploic Appendages Encountered at the Mayo Clinic**

	Symptoms	Examination						
Age							Leuko-	

TABLE 2.—*Cases of Symptomatic Epiploic Appendages Encountered at the Mayo Clinic**

Age and Sex of Patient	Preoperative Diagnosis	Symptoms					Examination					Operative Findings
		Pain										
		Duration	Type	Location	Nausea or Vomiting	Elimination	Tenderness	Rebound	Rigidity	Mass	Temperature	Leukocyte Count	
31 M	Appendicitis	Acute, 2 days	Mild, persistent	Right lower quadrant at onset	None	.....	Grade 1, right lower quadrant	+	0	0	Normal	6,500	Blue-black strangulated tag of the cecum in the right lower quadrant
30 M	Appendicitis	Subacute, 10 days	Sudden, sharp, recurrent	Right lower quadrant	Slight nausea	.....	Grade 3, right upper quadrant	0	Grade 1	0	Normal	10,700	Strangulated epiploic tag in the gastrocolic region
36 F	Appendicitis	Subacute, 8 days	Sharp, shooting, recurrent	Right lower quadrant	None	Diarrhea	Grade 2, right lower quadrant	Marked +	0	0	99 F.	6,700	Necrotic appendage removed from the cecal region
32 M	Appendicitis or cholecystitis	Chronic, 2 months	Moderate, severe, recurrent	Right upper quadrant	None	.....	Grade 2, right upper quadrant	0	0	0	Normal	9,500	Large hemorrhagic epiploic tag with twisted pedicle near round ligament of the liver
35 F	Pelvic inflammation	Chronic, 1½ years	Dull, constant	Pelvis and back	None	.....	0	0	0	Pelvic	Normal	.....	Inflamed epiploic appendage of the sigmoid forming a mass behind the uterus
69 M	Sigmoid tumor	Chronic, 6 weeks	Soreness	Lower part of abdomen	None	Costive	0	0	0	Pelvic	Normal	.....	Adhesions about inflamed tag of the sigmoid, partly obstructing the large bowel
54 M	Abdominal malignant disease	Chronic, 5 months	Acute, recurrent	Right lower and upper quadrants	Present	.....	Grade 1, right lower quadrant	0	0	Right upper quadrant	Slight elevation	9,900	Inflammatory appendage forming a mass near the hepatic flexure
19 F	Appendicitis	Subacute, 5 days	Steady	Above umbilicus	Repeated vomiting	Marked constipation	Grade 1, below umbilicus	0	0	0	Normal	22,000	Inflamed epiploic appendage of the cecum attached to the ileum giving partial intestinal obstruction. Secondary to subacute appendicitis
57 F	Appendicitis	Chronic, 10 years	Dull, soreness	Right lower quadrant	None	.....	Grade 1, right lower quadrant	0	0	Dome-like, right lower quadrant	99.4 F.	4,300	Acutely inflamed epiploic tag of the cecum overlying the appendix. Secondary to chronic appendicitis
38 M	Intestinal obstruction	Chronic, 2 years	None	.....	Present	Costive	0	0	0	0	0	0	Epiploic appendage forming obstructing band attached to the small bowel. Secondary to Meckel's diverticulum

* In addition to those reported by Hunt [6] in 1919.

were present. Possibly, it had been present in 4 other cases, but this is merely an assumption. In 3 cases of the symptomatic conditions in which primary pathologic processes of the tags were present, masses in the pelvis or the abdomen were palpated preoperatively, suggesting pelvic inflammatory disease, tumor of the sigmoid or malignant disease in the upper portion of the abdomen. These masses proved to be inflammatory masses surrounding diseased epiploic tags of the sigmoid or the hepatic flexure; other pathologic conditions were absent. In 1 case, adhesions produced partial obstruction of the large bowel.

In 3 cases of the symptomatic group, the diseased appendages were associated with other pathologic processes, which probably were primary; the involved tag, however, was the definite contributing factor leading to exploration. In 1 case, Meckel's diverticulum and an epiploic tag formed a ring obstructing the small bowel; in another, an inflamed tag had become attached to the ileum, producing obstruction in a case in which subacute appendicitis also was present. In the third case, exploration was performed because of a domelike mass present in the right lower quadrant of the abdomen. This mass was attributable to inflammation of an epiploic tag with surrounding adhesions. The tag was overlying a chronic catarrhal appendix. In each instance, the patient's condition was relieved or improved by removal of the offending tag.

The weight of patients who had diseased tags was noted, as a definite impression had been obtained that obesity or excessive loss of weight was a factor in the genesis of diseased tags. Considering 150 pounds (68 Kg.) as an arbitrary borderline, it was found that the ratio of obese patients to patients of normal or less than normal weight was nearly 2:1. Among patients who had primary symptomatic tags, the ratio was 5:2, and among those patients who had tags free in the abdomen, the ratio was 15:7.

The following report of a case illustrates the surgical problem presented by acute involvement of an epiploic appendage.

REPORT OF A CASE

The patient, a man 31 years of age, registered at the Mayo Clinic on Jan. 26, 1941, and was immediately hospitalized because of mild persistent pain in the right lower quadrant of the abdomen during the previous forty-eight hours. He had been in recent good health except for recurrent bouts of mild pain in the right lower quadrant of the abdomen, occasionally noted in the year prior to registration. At times he had had mild distress in the epigastrium and the right upper quadrant. The attack forcing his hospitalization was more severe than those experienced previously. Nausea, vomiting or other symptoms were not present. On examination, the patient was found to be slightly obese. There was definite intra-abdominal tenderness at McBurney's point, which became progressively more

marked. Rebound tenderness was referred to this region. There was no true rigidity of the abdominal wall. Rectal examination suggested more tenderness high on the right side. Although the temperature was normal and leukocytes numbered 5,500 per cubic millimeter of blood, with 64 per cent polymorphonuclear leukocytes, a diagnosis of appendicitis was made.

Exploration was carried out through a muscle-splitting incision in the right lower quadrant of the abdomen. A bluish black hemorrhagic epiploic appendage with complete torsion of the pedicle at its attachment to the cecum was removed, together with an adjacent inflamed tag. The appendix was normal but was removed (figure). Otherwise the abdomen was normal. The tag measured 1 by 3 by 4 cm. Pathologic section revealed hemorrhagic infarction and fat necrosis. Convalescence was uneventful.

Appendix and epiploic appendages removed at operation.

COMMENT

It is evident that pathologic epiploic appendages are observed with sufficient frequency to demand more widespread appreciation of their significance. It is further suggested that the 178 cases reviewed in this presentation probably represent only a portion of the total number of cases which would be revealed by more complete exploration. Although it is difficult to exclude disease of adjacent structures in the causation of 46 of these cases, it is clear that this secondary involvement may progress as an inflammatory or obstructing process requiring surgical intervention. Fifty-four of the tags recorded were detached. It is reasonable to assume that at times these may have caused previous

undiagnosed abdominal complaints. The recognition of these tags is essential. Although tags caused symptoms in only 10 cases in our series, they occur sufficiently often to deserve recognition as a definite cause of intra-abdominal conditions requiring operation.

Unfortunately, no clearcut factors can determine the diagnosis preoperatively, and any diagnosis before operation must be only tentative. A review of the symptoms presented reveals that pathologic conditions of epiploic appendages can suggest practically any acute or chronic intra-abdominal condition from pelvic disease to cholecystitis. The typical picture following acute torsion is considered to consist of moderate localized pain and tenderness in the abdomen of a rather obese young patient. There is little generalized reaction; the epigastric component of appendicitis and identifying criteria of other pathologic processes are absent. Actually, however, the temperature may be elevated and the number of leukocytes increased. Nausea and vomiting do not exclude the diagnosis, and abdominal masses or signs of obstruction may be encountered. It is apparent, therefore, that generally the diagnosis can be suggested only by the absence of other localizing signs.

Nevertheless, disease of the tags can be of definite importance to the patient. Although simple necrosis of the pedicle may allow a tag to detach and not cause further trouble, the presence of infection in the diseased epiploic tag by organisms derived either from contiguous bowel or some other structure may lead to peritonitis or localized reaction sufficient to cause obstructing lesions. That this outcome is sufficiently frequent to be a real hazard to the patient is revealed by a review of our cases in which symptoms were present and suggests the need of immediate operative treatment whenever diseased tags are encountered.

SUMMARY

An analysis of 178 cases in which abnormal epiploic appendages were encountered at operation at the Mayo Clinic from 1919 to April 1941 is presented. Of these cases, 61 represent instances of true intra-abdominal primary pathologic processes of the attached tag. The literature is reviewed, summarizing the cases of true symptomatic involvement of diseased epiploic appendages. Forty-nine were found to the date of writing. To this group we added 10 cases. Consideration is given to the symptoms and signs presented by diseased epiploic appendages in an effort to aid in diagnosis. Although a typical picture may be described, it is rarely adhered to, and even when the picture is present, the suggested diagnosis must remain tentative. The various conditions simulated and the pathologic states encountered at operation are discussed, and the surgical significance of epiploic appendages as a cause of acute and chronic abdominal conditions is stressed.

ACUTE SURGICAL PAROTIDITIS

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Under the title "acute surgical parotiditis" may be grouped all acute inflammations of the parotid gland except that occurring in mumps.

The condition has been written about under many other names. It should not be called secondary parotiditis, for it occurs also as a primary disease. The names "septic," "gangrenous," "suppurative," "phlegmonous" or "necrotic" describe only various phases of the one disease—differences in degree of inflammation. "Postoperative" is no more appropriate than "postpneumonic," since the disease occurs after a great number of other conditions—Custer enumerated some twenty-five, and the same disease occurs in those otherwise healthy (Nicol). It has been called sympathetic parotiditis because it was known to occur after injuries to the testicle and sometimes after even slight operations on the genito-urinary tract, e. g., passing of a sound, placing of a pessary or catheterization of the bladder (Paget). Later, when surgeons began to operate in the abdomen, it was thought to follow especially operations on the ovaries and the uterus. Möricke, remembering the metastasis of mumps, reasoned that if an inflammation of the parotids could excite an inflammation of the ovary, the converse also must be true. Bumm thought it an ascending infection but concluded that Möricke was right—"the parotid had its vascularity increased by operation on the ovary." There were many who agreed with Möricke, e. g., Paget and Goodell, but the theory seems to have been abandoned.

The condition is more often referred to in the literature as "parotitis," but the word "parotiditis" indicates that it is an inflammation of the parotid. We are then here concerned with an acute noncontagious, nonspecific inflammation of the parotid gland which arises from a variety of causes and which is, no matter what the cause, best treated by surgical means—hence the name.

It was Hippocrates who first described parotiditis, but not surgical parotiditis, for he clearly told of how it occurs in epidemic form and

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* Dr. Coughlin died on May 22, 1940. This paper was begun as a joint study and was completed by the junior author.

sometimes causes testicular inflammation. Surgical parotiditis never does either of these things. Celsus, however, spoke of a variety of parotiditis following protracted fevers and advised that the involved parotid be opened as soon as possible, while Galen spoke "of parotiditis that is of abscesses near [juxta] the ears" and advised poulticing. Murat [1] stated that the disease was known to Avicenna and that according to him, those of slow development were opened with the cautery and the others poulticed or opened with a knife. Avicenna, we have not been able to consult! Paré recognized this form of treatment. Petit (who died in 1750) discussed the subject and advised early opening no matter how hard. In the works of Sydenham, Cullen, Fothergill, Cheselden, Hunter and Astley Cooper we found no reference to it, but in Good's book, published in 1829, it is described, and the author criticized Cullen for having placed it "among the warts and skin lesions." Good plainly referred to the two varieties, but he somewhat confused the phlegmons with the new growths. Rust, in Germany, recognized both varieties and advised poulticing the surgical kind and not opening too early. Benjamin Brodie, in England, had about the same idea at that time. Cruveilhier, in France, who, like Hunter in England, did much to interest the world in the study of pathology, gave a description of this condition to which little, if aything, of importance has ever been added. He described and illustrated the condition, was of the opinion that the inflammation ascends from the mouth, that suppression of the saliva precedes it and that gangrene and suppuration are often present together.

It is strange how many articles give credit for all this to Virchow, who, writing twenty years after the publication by Cruveilhier, himself gave first credit to Cruveilhier for having had the correct idea of the pathologic nature of the condition. These conclusions of the celebrated French pathologist were confirmed first by Virchow and then by Hanau and others. Mosler, acting on the assumption that their ideas were correct, studied the saliva and concluded that its reaction changed in fever. He thought that he prevented the complication in typhoid by catheterization of the ducts and advised this as prophylaxis.

Galippe proved that even in young infants there are bacteria in the ducts although the glands are healthy. Girode, making bacteriologic and histologic studies of glands and ducts, found that the evidence in 12 cases pointed toward an invasion from the mouth. The bacteria in the ducts were fewer while the animal ate. Gilbert and Lippmann confirmed this in 1904. Claisse and Dupré in 1894 removed a normal gland as well as

1. Murat's article is found in a large encyclopedia arranged by the best authorities in Paris about the beginning of the last century, and there may be found almost everything that was then known on almost any subject in medicine or surgery.

the diseased one post mortem and studied both. They found the same bacteria in both and pus in both, although there was no fluctuation in either. There were some areas in each gland that presented the same histologic picture, but catarrh of ducts with intracanalicular debris, even in those parts least inflamed, pointed to an ascending infection. Claisse and Dupré came to conclusions, it would seem, before they made their animal experiments. They were able to produce parotiditis in the animal if they first injured or obstructed a gland or a duct—but not always. We found no record of experimental attempts made by them to produce parotiditis by blood stream infection. Rost, however, in 1914, tried to induce parotiditis not only through the blood stream and through the duct but also by contiguity. In both of the first two methods, he was successful; in the last, he was not. He had his best success in exciting parotiditis by blood-borne infections. By microscopic examination, he was unable to distinguish the blood stream variety from that arising from duct infection. Berndt, Buck and Buxton in 1931 repeated such experimental work. They found it easier to excite parotiditis by duct injection than by injections through the artery. They also found a difference in the histologic picture. The route of infection, therefore, is not proved. Yet it seems that most of those who have written about it were of the opinion that it is an ascending infection. However, there have been many apparently contradictory phenomena, and all have not accepted that theory. Many have expressed the opinion that the infection is carried to the gland by the blood. In 1880, Wendt studied a gland twelve hours after the onset of the disease and concluded that the ductal changes were secondary. Since then the doubt has existed. Those who contend for an ascending infection base their belief on the microscopic picture as interpreted by Virchow and others, and maintain that were the condition metastatic, one would always find the organism present in an original focus, that there would always be a suppurating wound or focus to precede the parotiditis and that other metastatic abscesses would always accompany, precede or follow. Others reply that were it an ascending infection, there should be found the same organisms that are present in the mouth and never a sterile culture from the gland, that mouth infections would favor it, whereas it is an unusual complication of any acute mouth or throat infection and that if it is an ascending infection, it must be explained why the submaxillary gland does not become inflamed more often, since the papilla is more likely to admit a foreign body and stones are more common in Wharton's duct than in that of Steno.

Seifert claimed that the mucin content of the submaxillary gland hindered bacterial growth. He found that the less the saliva, the more the bacteria and that in and near the canine fossa, bacteria were more

numerous than under the tongue. We have not found confirmation of his experiments.

Rolleston and Oliver, in 1909, reviewed the occurrence of parotiditis in 1,000 cases of peptic ulcer treated medically. They found that parotiditis occurred ten times more frequently in cases of peptic ulcer treated by oral starvation (470 cases with 4 per cent parotiditis) than in cases in which the patient was allowed water by mouth (530 cases with 0.4 per cent parotiditis). This is a most valuable observation. Cope, in Mesopotamia in 1919, had 9 cases of parotiditis, all in the hottest weather (120 F.) and all in dehydrated and debilitated patients.

ANATOMY OF THE PAROTID GLAND

The parotid gland is the largest of the salivary glands and secretes a watery saliva. The gland is a compound acinar gland of the racemose type which arises in the embryo as an outgrowth from the alveololabial sulcus and passes outward and backward as a process of giving rise to buds, which divide to form the lobules of the gland. The epithelium of the terminal ends forms the secretory alveolar epithelium and that of the stalk gives rise to the lining epithelium of the ducts. The parotid duct (Steno's or Stensen's) is similar to, but not as large as, the ureter and empties by peristaltic waves.

The main portion of the gland is superficial and somewhat flattened and quadrilateral in shape; it lies anterior to the ear and below the zygoma with one extension below the ear, backward and upward behind it toward the base of the mastoid and another passing medially behind the ramus of the mandible to the side wall of the pharynx, the glenoid portion of this extending toward the tympanic region. This glenoid portion of the gland comes into direct relation with the cartilaginous part of the external auditory canal. There are several vertical fissures (Santorini) in that cartilage in this region, covered only by a fibrous tissue. Much has been made of this as a pathway for lymph flow between middle ear or mastoid and parotid. However, "the fissures are in the posterior superior wall in the inner end of the cartilage of the canal" (Gray).

The parotid duct leaves the anterior portion of the gland about a fingerbreadth below the zygoma, passes over the anterior border of the masseter muscle and into the mouth through the buccinator muscle to end in the papilla opposite the second upper molar tooth. Sometimes the accessory glandule, the socia parotidis, lies along its upper border and from this a small duct joins that of Stensen before the latter leaves the masseter muscle.

The facial nerve emerges from the skull between the mastoid and styloid processes and finds its anterior and external aspects in immediate

relation with the parotid gland. The nerve gives off the posterior auricular branch and branches to the digastric and stylohyoid muscles and then enters the parotid gland; altogether, its course from skull to gland is usually not more than 1 cm.—often not that long. As soon as it enters the gland, it breaks into branches which unite with one another and again divide, reunite and subdivide irregularly to form the plexus parotideus or pes anserinus in the deep half of the gland. The three divisions of the nerve leave this plexus and course toward their final destinations, emerging from the gland near or quite at its anterior border. This arrangement of the nerve is important to remember when operating on the gland. It will be remembered that this nerve travels through the tympanum covered only by the mucous membrane and along its perineural lymph space infection might easily travel from middle ear to parotid.

The parotid gland is in close relation with the upper half or two thirds of the external carotid artery. The gland with facial nerve and temporomaxillary vein in its substance lies external to the artery below, but as the artery ascends, it enters the gland. At the level of the neck of the condyloid process, the carotid ends by dividing into the internal maxillary and superficial temporal arteries. This is just about the level of the external auditory meatus. The superficial temporal ascends through the gland, gradually becoming more superficial and leaves the gland entirely by crossing the zygoma just in front of the ear. While in the gland, it gives off the transverse facial which runs forward in the gland below the zygoma and above Stensen's duct. The internal maxillary runs forward to disappear under the neck of the mandible.

The veins accompanying the arteries lie on their outer sides and hence are more superficial and have a longer course within the gland substance than the corresponding artery. Most important and largest is the temporomaxillary vein formed in the gland just in front of the meatus externus by the union of the temporal and internal maxillary veins. It courses downward and soon divides—an unusual thing for a vein to do. Its anterior branch courses forward to become superficial and join the facial vein just deep to and below the lower border of the jaw and about a fingerbreadth in front of its angle to form the common facial; the posterior branch, descending, joins the posterior auricular within the gland to form the external jugular behind the angle of the jaw.

It will thus be obvious that to cut freely into the gland would probably cause profuse bleeding and perhaps divide at least some of the branches of the seventh cranial nerve. It is also to be noted that the least vascular part lies close to the ear. Incisions here would be less likely to have unpleasant consequences.

Enclosed as it is in a fascial sheath, the parotid gland is actually surrounded by a lymph space. It should not be forgotten that each vessel that enters, leaves or lies alongside of the gland, is surrounded also by its own sheath, again a lymph space, and that on its deep aspect, between the gland and the pharyngeal wall, lies a layer of loose cellular tissue in which lie the great vessels and nerves and a rich venous plexus; again such loose, cellular tissue becomes an enormous lymphatic reservoir. In addition to this, however, the gland has a system of lymph glands and vessels of its own. The glands are two or three in number, lie in front of the tragus and usually at least one is outside the sheath. There is said to exist a direct lymphatic connection between the middle ear, the deep portion of the auditory canal and the parotid through the previously mentioned slits in the anterior wall of the canal. The efferent drainage is to both the superficial and the deep cervical glands, and usually those under the sternomastoid just below the gland show the greatest swelling in infectious parotiditis.

The fascia covering the gland is derived from the cervical fascia. It consists of: (1) an external layer attached to the zygoma above, to the external auditory canal near its outer end, continued down as the cervical fascia below and blended with the fascia covering the masseter anteriorly; (2) an internal layer lining the parotid recess, attached to the periosteum and perichondrium over the external auditory canal and glenoid fossa posteriorly, to the styloid medially, to the stylomandibular ligament and to the deep cervical fascia below. Together the two layers form a tough and unyielding capsule with its weakest points where the layers join the cervical fascia below and in the region of the auditory canal. This fascia is closely applied to the gland and adheres firmly to it by means of fascial septums which pass from its deep surface inward between the lobes and lobules so that the fascial capsule cannot easily be reflected nor can the capsule yield easily to accommodate the exudate when acute inflammation occurs in the gland. The high tension soon cuts off the circulation, and this is the chief reason why gangrene of the gland occurs so early in acute infections of the parotid.

PATHOLOGIC CHARACTERISTICS

There are four possible routes by means of which infection may gain entrance to the gland: (1) through the lymphatics; (2) through the blood stream (hematogenous); (3) via the parotid duct, and (4) by direct extension from contiguous tissues.

Although there is said to be no direct lymphatic connection of the parotid with the oropharynx and although it has been said not to follow conditions affecting the mouth and the throat, we noted the condition after sore throat and after tonsillectomy as well as after tooth extraction

(cases 19, 28, 29 and 30). Of course, this does not prove direct lymphatic extension, but there is that possibility. We have noted before that lymph from the middle ear and the tympanum drains into the parotid lymph nodes. When the middle ear is infected, direct extension along the lymphatics can lead to abscess in and around the anterior auricular node or to general parotiditis (case 25), and various authors, e. g., Hempstead, Adams and Wilson, reported cases of parotiditis associated with otitis media resulting, in their opinion, from direct lymphatic extension to the parotid. In some cases, the resulting inflammation of the parotid is diffuse and in others an abscess in the region of the superficial lymph nodes. A case was reported as following an infected wound of the forehead (Blair). Our case 34 followed a blow of a fist. However, we find no experimental or clinical proof of the extension of the infection to the parotid by way of the lymph channels.

We have referred to the experimental work in which it was shown that parotiditis may be produced by blood stream infection. Cases of parotiditis with identical bacteremia or septicemia are not frequent in the literature, and none were present in our series. However, a case from the private practice of one of us (W. T. C.) will be cited later to show that such may happen.

The arteriolar and capillary bed in the gland does not conform with the terminal type, and although lodgment of bacteria in the gland during septicemia is possible, in the literature parotiditis has seldom been reported as associated with pyemia or septicemia—a blood stream infection accompanied by parotiditis is not often found. In Paget's 101 cases, there were only 7 in which other lesions pointed to pyemia.

We have mentioned the arguments pro and con infection via the duct. In our opinion this is by far the most common way. The reports of Rolleston and Oliver are convincing. Our own experience forces us to believe that a dry mouth is almost always present—for one reason or another the saliva does not flow. Bacteria are always to be found within the orifice of the duct (Galippe, Girode, Claisse and Dupré). Because they are not constantly washed out, they ascend. The lowered vitality shown to be necessary by all experimental work furnishes the opportunity for their further growth.

We do not find that parotiditis has been experimentally produced by infecting the contiguous tissues, and although cases have been recorded as following trauma to tissues near by, there may often be some doubt as to the correctness of the diagnosis of parotiditis. Claisse and Dupré, by injuring simultaneously both gland and duct by trauma, excited parotiditis.

Between 1836 and 1842, Cruveilhier published and illustrated a description of this disease. He contended that the infection ascends

from the mouth and finally reaches the terminal canaliculi and acini and then invades the cellular tissues. In 1858, Virchow in his usual way, went thoroughly into the question and concluded that "Cruveilhier was right—it ascends the duct and invades the gland substance as broncho-pneumonia invades the lung." In 1880, Wendt examined a gland which had become inflamed only twelve hours before the patient died. He thought that the disease was brought to the gland by the blood and that ducts and acini were secondarily involved. Studies were made also by Cornil and Ranvier.

Hanau, after studying the glands in 4 cases microscopically from the pathologic point of view, agreed with the first authors. Since then much has been written on both sides of the question. We think the studies of Custer and co-workers are the best that have been made in recent years and have the best verified bibliography. They are supporters of the ascending infection theory.

Practically all are in agreement with regard to the pathologic histologic nature. There are pus cells in ducts, acini and interacinous tissue. The earliest stages are about the canaliculi, in which exists mild catarrh with simple accumulation of desquamating epithelium. There is peri-canalicular accumulation of round cells. The capillaries and the smaller vessels contain blood clot. According to Claisse and Dupré and others, the changes are least marked toward the periphery of the lobules, and often whole lobules escape. These are changes agreed on by the French and most other authors. Some, e. g., Berndt, go so far as to say that the larger ducts are involved in ascending infections, the smaller, in those deriving from the blood stream. At first, myriads of small aggregations of leukocytes form in canaliculi and distending these, rupture their walls and result in minute abscesses.

The exudation ensuing on account of the inflammation cannot easily find a place for itself because of the dense connective tissue capsule and the almost equally strong interlobar and interlobular septums extending in from the deep surface of this capsule. As the tension rises, first the venous circulation is retarded, and if the process progresses, it need not be long until complete stasis occurs. It also is probable that in certain infections the toxins liberated are of such a nature as to destroy chemically cells with which they come into contact. However it may be, any lobule or lobe or any number of them or even the whole gland may be so deprived of its circulation that gangrene may supervene in an extremely short time. Because of the same strong septums and dense connective tissue capsule, accumulation of pus in hindered, and pus is prevented from appearing in the fatty layer between gland and skin, so that although pus is present in abundance, the clinical sign of its presence—fluctuation—can never appear until late in the disease (Wag-

ner, Picqué, Petit and others). We have found early gangrene and early general purulent infiltration, but never have we found early gross abscess formation.

It has been stated before that the capsule is less dense and firm on the deeper surface of the gland. Should a deep portion of the gland become first involved, early extension through this part of the capsule is probable. There is an extremely weak spot below and anterior to the styloid process and along the stylohyoid muscle. Thus the precincts of the submaxillary space may become invaded, and the diagnosis of inflammation of the submaxillary gland may be wrongly made. From here it is easy for the pus to travel downward along the great vessels, or breaking the posterior part of the capsule deep to the anterior margin of the sternomastoid, it spreads directly downward and backward under this muscle and under the trapezius. Mastoiditis has accompanied it; whether as a cause or a consequence is not certain (Picqué). Another weak spot in the wall of its lodge is in the anterior wall of the external auditory canal, and through this, pus may break before suppuration is thought to exist. Indeed, it has even broken into the ear after operation because the gland capsule was not incised. Again from the deep aspect higher up, pus soon comes to lie directly in contact with the base of the skull and even extradural abscess, meningitis and psychic phenomena have been caused by intracranial spread (Everke, Picqué). The temporomandibular joint may become involved, and permanent constriction of the jaws may result. This constriction is always present early, the jaws being reflexly closed because any attempt to open compresses the inflamed gland. Some stiffness may remain, and one of us (W. T. C.) has reconstructed a temporomandibular joint in which bony ankylosis was said to have followed parotid inflammation.

The papilla is sometimes swollen, and the mucosa about it reddened, but not in all cases. Sometimes pus is seen exuding from the papilla. From ducts of the acutely inflamed glands, we have not been able to express saliva or pus in any appreciable quantity, but from the mildly or subacutely inflamed glands, one of us (E. R. G.) has expressed shreds of mucopus. There is often mention of plugs of pus having been expressed from the duct (Johnson).

We have stated that clots are to be found in many of the smaller blood vessels. It is not unusual to find at operation larger veins so filled with clot that they do not bleed when severed. This we have observed of the external jugular vein and the two veins which form it and also of the superficial temporal vein. Virulent parotiditis might thus quickly send septic emboli to the lungs.

It has been remarked that gangrene is often present. This may be complete in twenty-four hours (cases 16, 26, 39 and 40), and it may

destroy the facial nerve permanently in that time (case 26). Gangrene may be present, and cultures yet fail to show any growth. But sterile cultures from the duct are rare.

BACTERIOLOGIC FINDINGS

The most commonly found organism is the staphylococcus, but streptococcus and a rod, gram-positive or gram-negative, are frequent enough. It is not unusual to find one or more organisms in the duct and others different in the gland. Not more than once have we seen the organisms of Vincent, although we have several times expected to from the odor.

We were able to have cultures from 37 incised glands, but in only 10 of these had cultures been made also from the ducts.

Cultures from the Duct and the Incised Gland.—Cultures were made from the ducts and the incised glands of 10 patients. The growths obtained were as follows:

Staphylococcus alone in both the duct and the gland (aureus, or aureus and albus)	3 cases
Staphylococcus in the duct; staphylococcus and gram-positive rods in the gland	1 case
Staphylococcus and streptococcus in the duct; staphylococcus alone in the gland	1 case
Gram-positive rods and staphylococci in the duct; staphylococcus in the gland	1 case
Gram-positive rods and staphylococci in the duct; no growth from the gland	2 cases
Gram-positive bacilli from the duct; no growth from the gland	1 case
Gram-positive bacilli and spirilla from the duct; no growth from the gland	1 case

Cultures from the Incised Gland.—Twenty-seven cultures from the glands (cultures from the duct forgotten) yielded growths of the following organisms:

Staphylococci from 23 glands, with 7 deaths
Staphylococci and gram-negative rods from 1 gland; no death
Paired gram-positive cocci (pneumococci?) from 1 gland; no death
Hemolytic streptococci from 1 gland; no death
Nonhemolytic streptococci from 1 gland; no death

The predominance of staphylococcus accords with the general experience. We were able to have blood cultures from 17 patients, in most cases daily. In only 1 case (55) did the blood stream show infection (Streptococcus haemolyticus), but the gland gave a pure culture of staphylococcus. In 10 cases (6, 16, 19, 26, 30, 39, 40, 45, 46 and 51), the

gland was incised within twenty-four hours, and in only 3 of these (6, 19 and 26) was pus visible, although in all there was acute inflammation. In 5 of those in which pus was not demonstrated, cultures were made, and all yielded a growth of staphylococcus. There were 12 cases in which the gland was incised during the second and third twenty-four hours. In 8 of them, no pus was demonstrated, but in 7 of these cultures were made, only 1 of which was negative. In 4 in which there were infected abdominal wounds, both the wound and the gland were cultured. In only 1 (case 36, a wound abscess) were the same organisms present in both the wound and the parotid.

INCIDENCE OF PAROTIDITIS

The incidence of surgical parotiditis has received little attention, and the disease is considered infrequent, while it really occurs more often than supposed.

Picqué listed only 2 cases occurring among 7,200 surgical procedures (1:3,600). Beckman recorded 3 cases in 6,825 surgical procedures (1:2,270). Collins reviewed 8 cases in 6,100 cases of postoperative abdominal conditions (1:762). Charlton reported 13 cases in 2,716 surgical procedures (1:209). Combs reported 9 cases among 13,000 cases in which anesthesia was employed (1:1,450). Lynn gave 3 cases in 947 operations (1:315). All these were cases of postoperative parotiditis. Little reference is made in the literature to the occurrence of parotiditis in the medical services.

We have studied the incidence of parotiditis in our hospitals from January 1926 to January 1939. Our hospitals are two in number, namely, St. Mary's Hospital and Firmin Desloge Hospital. (The latter replaced the St. Mary's Infirmary in 1933.) The St. Mary's Hospital is regarded as "the private pavilion" of the University's hospitals, while the Firmin Desloge Hospital, "a hospital for poor people and people of moderate means," is the clinic hospital. The St. Mary's Hospital is an open hospital wherein the faculty of the school of medicine exercises a "power of selection" of the visiting staff, and Firmin Desloge Hospital is open only to members of the teaching faculty. The cases herein reported, then, are not those of any one surgeon and may be said to represent the general surgical practice in St. Louis. During the period of our study, 95,367 patients in all services were admitted to our hospitals, and in these there were altogether 56 cases of parotiditis. However, 12 of these cases did not develop in the hospital, but the patients were admitted because of the condition. Therefore, in 95,355 hospital patients, the disease developed 44 times (1:2,167).

In the medical services alone there developed in the hospital 16 cases in a total of 28,456 patients; 8 patients had the disease when they

came in. Thus, 1 case developed in the medical service for each 1,779 admissions.

In all surgical services, to which 45,389 patients were admitted, there were 32 cases of parotiditis, but 4 of these were present when the patient entered, so that only 28 cases developed in the hospital (1:1,621), and 23 of these followed major operations (1:650).

A striking fact is the complete absence of parotiditis among the 21,514 obstetric and newborn patients.

REPORT OF CASES

Twenty-four cases complicating medical conditions

CASE 1 (St. Mary's Hospital).—A white man aged 60 entered on May 20, 1928, following the onset of lobar pneumonia which involved the entire right lung. The patient was recovering when, on June 3, he complained of a sore neck in the region of the parotids. The gums were described as dirty and bleeding at the time of the onset of parotiditis. By June 5 there was bilateral swelling of the parotids, the right gland being the more swollen. The white blood cell count was 12,400. During the acute swelling, swallowing was difficult. Ice packs were applied and oral hygiene was given. The pain and the tenderness subsided by June 15, the twelfth day of parotiditis, and the white blood cell count dropped to 5,600. The patient recovered.

CASE 2 (St. Mary's Hospital).—A white man aged 23 years entered in diabetic coma on Sept. 7, 1929. The blood sugar content was 666 mg. The pharynx was red and injected and the teeth carious. The following day, when the patient was conscious, he complained of sore throat and pain in the neck. Examination revealed foul breath and ulcerated gums. During the night, swelling of the left parotid began. The white blood cell count was 21,000; the temperature was 102 F. Fluids were given by mouth, and ice packs were applied to the gland. The inflammation and the swelling increased, and within forty-eight hours, the swelling involved the eyelids, the cheek and the neck, extending around the back of the neck. There were purulent discharge from the external auditory meatus and fluctuation in the temporal region. The skin overlying the gland and the neck was red and brawny. With the patient under anesthesia induced with ethylene, a Y incision was made over the left parotid, freeing a large amount of pus. The swelling and inflammation of the gland gradually subsided, and the wound drained freely. The wound was healing, but there was some discharge from the wound when the patient was sent home on September 20.

CASE 3 (St. Mary's Hospital).—A white man aged 53 years entered on Nov. 9, 1929, with the diagnosis of advanced cardiovascular renal disease with hypertension. The blood pressure was 190 systolic and 90 diastolic. The nonprotein nitrogen was 93 to 120 mg. The urine showed albumin, cells and casts. The patient's tongue was coated; the teeth were unclean, and the pharynx was covered with a mucopurulent material. On Nov. 23, 1929, a rapidly developing, diffuse, hard and tender swelling occurred in the right parotid area. There was no redness of the skin, but the area was painful and edematous. The left parotid area was also slightly swollen and tender. The white blood cell count was 7,300. Mouthwash, oral hygiene and ice packs were used. By the third day, the left side had completely subsided. The next day there was an increase in the right-sided swelling; no pus was visible at the duct papilla. The inflammation gradually subsided to December

6, the thirteenth day of parotiditis. The patient was complaining of severe precordial and substernal pain on December 6 and 7 and died suddenly on December 8. Autopsy was not performed.

Case 4 (St. Mary's Hospital).—A white man aged 25 years entered March 30, 1931, with marked swelling of both parotids. The swelling began in both glands suddenly forty-eight hours before entrance, but the right gland enlarged more rapidly than the left. On entry, examination revealed that both glands were hard, hot and tender with red overlying skin. The patient had difficulty in swallowing. The mouth was foul, there being marked pyorrhea and pharyngitis. Both papillae of the ducts were red and elevated, and pus was draining freely into the mouth. There were swelling of the soft palate and some swelling and tenderness of both submaxillary glands. The temperature was 102 F. The white blood cell count was 14,000. Throat cultures revealed pneumococci and staphylococci. Sodium perborate gargles were used frequently, and hot packs were applied to both glands. Under conservative treatment, the glands gradually subsided, draining into the mouth, and the patient was discharged on April 11.

Case 5 (St. Mary's Hospital).—A white woman aged 69 years entered in a semiconscious state with a diagnosis of secondary parotiditis and diabetic coma on Sept. 16, 1932. The blood sugar content was 550 mg. The white blood cell count was 15,500. Four days before entry, a swelling began below the left ear. On entry, examination revealed a red firm tender swelling extending from under the left ear and jaw up to the hair line accompanied by edema of the eyelids. Pus was draining from the left external auditory canal. The mouth was dry, and the pharynx was injected. The temperature was 100 to 101 F. The pain in the gland persisted. On September 20, the eighth day, with the patient under local anesthesia, a vertical incision 1 inch (2.5 cm.) long was made in front of the left ear, revealing a gangrenous gland and freeing a small amount of pus which on culture yielded a growth of Staph. albus. By September 21, swelling of the right parotid occurred and rapidly increased so that the edema had closed both eyes. Pus was draining from the right auditory canal. After twenty-four hours, ice packs were changed to hot wet packs. On September 23, pus was draining into the mouth "in the region of both tonsillar fossae." By September 25, there was gangrenous discoloration back of the left ear in the mastoid area, but there was rapid decrease in the size of both glands with profuse drainage from the left gland. The patient was discharged on September 28, with the left gland draining and a gangrenous area present behind the left ear at the mastoid tip.

Case 6 (St. Mary's Hospital).—A white woman aged 21 years entered Oct. 9, 1932, with pernicious vomiting from malignant hypertension with nephritis. The blood pressure was 210 systolic and 140 diastolic. The nonprotein nitrogen was 75 mg. The mouth showed poor hygienic condition, and treatment for this was given. The malignant hypertension was rapidly progressive. Throat culture before onset of parotiditis showed gram-positive cocci in gray colonies. On November 3, the patient's temperature rose from normal to 101 F., and swelling began in both parotids, but chiefly in the right, which was swollen, sore and tender. Ice packs were continuously applied during the first twenty-four hours. The tongue and the mouth were dirty, and cleansing mouthwash was given. Blood cultures during the first forty-eight hours were negative. The swelling of the right gland increased rapidly in twenty-four hours, and respiration became labored. The gland was opened twenty-four hours after onset of the disease, and 10 cc. of pus was freed, which on culture yielded a growth of gram-positive cocci in clusters. Cultures from

the duct orifice grew gram-positive cocci in groups and chains. Within forty-eight hours of the onset of parotiditis, the patient became comatose. The parotid swelling subsided, but the patient's temperature rose to 104 F., and the nonprotein nitrogen above 75 mg. The patient died on November 5 within forty-eight hours of the onset and twenty-four hours after operation. Autopsy was not done.

Case 7 (St. Mary's Hospital).—A white man aged 84 years with the diagnosis of cerebral anemia, aortitis and advanced arteriosclerosis, entered in an irrational state on Jan. 8, 1933. On the second day, a small lump, hard and tender, appeared at the angle of the right jaw. It was diagnosed as parotiditis. The next day the swelling increased rapidly, extending and enlarging below the right mandible. No stone was palpable, and no pus could be expressed from the duct, which was described as normal. The white blood count was 26,500 with an infectious Schilling count. The patient's temperature rose from 99.8 to 103 F. He grew rapidly worse, became weaker and died January 15 on the fifth day of parotiditis. No autopsy was performed.

Case 8 (St. Mary's Hospital).—A white man aged 49 years entered on April 28, 1933, with acute swelling of the left parotid of four days' duration, diagnosed as acute secondary parotiditis. There was acute inflammation and swelling in the left parotid area with red overlying skin. Pus exuded from the orifice of the left duct, and the papilla was red and edematous. The temperature was 102.4 F. The white blood cell count was 19,000 with an infectious picture. The gland was incised by a vertical incision in front of the ear, and hot packs were applied. Culture from the pus found in the gland gave a growth of staphylococci. The gland tissue was edematous with multiple pus pockets. Within forty-eight hours, the swelling had decreased, and the patient was discharged after seventy-two hours with a draining parotid wound, eight days after onset.

Case 9 (St. Mary's Hospital).—A white woman aged 71 years with the diagnosis of bilateral nephrosclerosis, lithiasis, pyelonephrosis and cardiovascular disease, entered July 24, 1934, semicomatose in acidosis. Marked pulmonary edema was present. On July 29, swelling of the left parotid began, and ice was applied. After forty-eight hours, an enlargement of the right parotid occurred, more marked than on the left and more tender and painful. The temperature was 101.8 F. A blood culture was negative. In the next two days, the right gland became less tense, and on the seventh day after onset, with the patient under local anesthesia induced with procaine hydrochloride, the right gland was opened through a 1 inch (2.5 cm.) incision in the capsule. The gland was creamy white with small "nodules of pus." The patient was in a critical condition at all times and died on August 4, six days after onset. Death was attributed to uremia and toxemia.

Case 10 (St. Mary's Hospital).—A white woman aged 49 entered on Sept. 5, 1935, with a history of chronic otitis media on the right and a swelling in the left parotid area present for four days. A similar swelling had occurred in the same gland a year before. On entry, the left gland was swollen, painful and tender but not red. Oral hygiene was good. The white blood cell count was normal. Heat was applied and mouthwash given frequently, and the swelling gradually subsided. The patient was discharged on the eighth day after onset. No stone could be found by roentgen examination.

Case 11 (St. Mary's Hospital).—A white girl aged 9 years with history of bilateral mumps a month before entered on August 25, 1935, with the diagnosis of acute secondary parotiditis. There was moderate swelling of the right parotid,

which increased in size, becoming tender and painful. The white blood cell count was 8,500, and the temperature was 100 F. The buccal membranes were red and injected on the right side. By September 4, ten days after onset, the swelling had restricted opening of the mouth, and with the patient under local anesthesia the gland was incised vertically in front of the ear, freeing about 10 cc. of pus, which on culture yielded a growth of Staph. albus. Drainage of the pus continued until the patient was discharged on the sixteenth day.

CASE 12 (St. Mary's Hospital).—A white man aged 25 with a history of rapidly increasing jaundice, nausea and vomiting entered Sept. 29, 1935. The condition was diagnosed as acute catarrhal jaundice. The white blood cell count was 17,600; the temperature was 99.4 F. The mouth and the lips were dry, and the tongue was coated. On October 7, a swelling of the left parotid occurred; it became large, painful and tender. The white blood cell count was 21,000; the temperature was 99 to 100 F. Ice packs were applied and oral hygiene instituted. The swelling decreased in size but was still present when the patient left the hospital on October 8.

CASE 13 (St. Mary's Hospital).—A white woman aged 45 with a diagnosis of coronary and hypertensive vascular disease entered Nov. 4, 1935, after a recent abdominal upset thought to be pancreatitis. The nonprotein nitrogen was 55 mg. On the day of entry, a hard swelling 1 inch (2.5 cm.) in diameter was palpable in the left parotid region. The white blood cell count was 7,225, with a shift to the left. Ice packs were applied and gargles given. In twenty-four hours the upper lobe was enlarged and there was a hard mass in the lower parotid area. In forty-eight hours, the inflammation began to subside, and the patient was discharged on the fourth day after onset. The patient's temperature ranged from 98.6 to 99 F.

CASE 14 (Firmin Desloge Hospital).—An elderly white man aged 87 entered on Sept. 6, 1935, because of urinary obstruction arising from a malignant papilloma in the urinary bladder. There were metastases to the lung confirmed by roentgen examination. The patient had also anginal attacks due to advanced cardiovascular disease. In addition he had severe arthritis and lived in the ward for patients with incurable diseases. In November 1935, he endured severe anginal attacks and rapidly grew weaker. On Jan. 22, 1936, a swelling began suddenly in the left side of the face, rapidly enlarging and becoming hot and tender and red. The patient's temperature rose from 99 to 103 F., and he died suddenly within twelve hours after onset. There was no autopsy.

CASE 15 (St. Mary's Hospital).—A white woman aged 66 years with the diagnosis of advanced cardiovascular disease with hypertension, entered on Dec. 27, 1935, following an episode of acute bronchitis of four days' duration. The blood pressure was 200 systolic and 90 diastolic. The patient improved until Jan. 18, 1936, when a moderate swelling developed at the angle of the right jaw, tender and painful. Ice packs, oral hygiene and gum chewing were used, and the swelling subsided by January 23, five days after the onset.

CASE 16 (St. Mary's Hospital).—A white woman aged 32 entered on March 9, 1936, with a history of chronic otitis media on the left and acute bronchitis of ten days' duration diagnosed as bronchopneumonia. The white blood cell count was 15,600. The day after entry, March 10, a painful tender and marked swelling of the left parotid occurred. There was rapid enlargement of the gland, and pus was draining from the duct. The left gland was incised on March 11. It was swollen. There was no pus, but the gland was gangrenous. Culture showed Staph. aureus.

On the evening of March 11, the right gland rapidly enlarged and became tender. The temperature was 101 F. The white blood cell count was 25,000. A blood culture was negative. Within twenty-four hours there was rapid increase in the swelling with increase of temperature to 102 F. and of the white blood cell count to 35,000. The right gland was then incised in the same way; it was a dark slightly necrotic gland which on culture gave a growth of Staph. aureus. Following incision, the white blood cell count dropped to 14,000, and the glands drained thick pus for a week. In several days there were ulcers present in the mouth and swelling of the left submaxillary gland. When the submaxillary duct was opened, pus exuded; pus also drained from the left parotid duct. Two weeks after the glands were opened, a state of mental confusion developed, which was diagnosed as toxic psychosis. The parotid incisions were healed in four weeks, but the psychosis persisted for some time after the patient's discharge.

Case 17 (St. Mary's Hospital).—A white woman aged 75 years with hypertensive cardiovascular disease with recent cerebral hemorrhage entered in uremic coma on July 11, 1936. The nonprotein nitrogen content was 100 mg. Urinalysis showed many cells, casts and albumin. Three days after entry, July 14, there occurred a gradually enlarging swelling of the right parotid. Ice packs were applied, but gradual enlargement continued so that by July 16 it involved the cheek and caused edema of the eyelids, also extending into the neck, resulting in difficult respiration and swallowing. The swelling had subsided somewhat when the patient died on July 19, five days after the onset.

Case 18 (Firmin Desloge Hospital).—A white man aged 58 suffering from tertiary syphilis, pernicious anemia and advanced nephrosclerosis entered on Nov. 22, 1936, with orthopnea, dyspnea, edema of the extremities and painful joints of two weeks' duration. The nonprotein nitrogen content was 95 mg. On November 26, the patient became comatose and remained stuporous to the end. On December 16, a swelling began in the right parotid area, and ice bags were applied, but the edema and the inflammation were progressive so that by December 18 the gland was enormous, red and tender but not fluctuant. The mouth was filthy, with sores on the lips and the tongue, although mouthwash had been given routinely. A blood culture was negative, and a culture from the duct orifice yielded gram-positive cocci and gram-negative rods on December 20. Hot packs were applied, and the gland became fluctuant, but incision was refused. Seven days after onset, the parotiditis on the right began to subside while the left gland rapidly became swollen, and ice packs were applied. The culture from the left duct grew gram-positive cocci in clusters. The comatose state of the patient deepened on December 25, and he died. At no time did the patient's temperature go above 99 F.

Case 19 (St. Mary's Hospital).—A white woman aged 42 with a history of severe sore throat, fever and chills entered Dec. 31, 1936, with a red injected pharynx and a coated tongue, but the teeth were in a fairly good state of repair. The white blood cell count was 14,000. A throat culture grew hemolytic streptococci. On Jan. 1, 1937, a small swelling began below and behind the right ear, and the face appeared red and swollen. In twenty-four hours a brawny edematous swelling was present, and the gland was incised and drained. A wound culture gave hemolytic streptococci. Ice bags were applied. Within forty-eight hours of the incision there was an erysipeloid rash at the site of drainage. The urine showed casts, albumin and cells. The temperature was 100.8 F. The parotid swelling subsided, but the erysipelas rash spread to the nose, the lips, down the neck to the scapular regions, the axillas and to the buttocks. Antiserums and convalescent

erysipelas serum were given, and magnesium sulfate packs were applied. The patient recovered and was discharged on January 22.

CASE 20 (St. Mary's Hospital).—A white man aged 60 years had pharyngitis, nodular goiter with auricular fibrillation and pneumonia in the upper lobe of the right lung of three days' duration. The temperature was 105 F. The white blood cell count was 31,000. A blood culture was negative. The patient received 40,000 units of antipneumococcic serum. The patient was weak and jaundiced on entry. On Jan. 27, 1937, parotiditis began on the right and rapidly developed, involving the whole side of the face and the neck. Mouthwash and gargles had been given continuously. Hot packs were applied. The patient died on January 28, within twenty-four hours of the onset of parotiditis.

CASE 21 (St. Mary's Hospital).—A white woman aged 29 with a history of bilateral mumps in childhood, rheumatic heart disease and Still's disease since 1931 entered with the diagnosis of Still's disease and acute secondary parotiditis on July 16, 1937. Her complaint was of painful joints and swelling in the left parotid of recent onset. The temperature was 103 F. The following day there was localization and brawny edema. The duct papilla was red, edematous and elevated, but no pus could be expressed. Ice bags were applied and mouthwash and gargle used. On July 18, with the patient under local anesthesia, the gland was incised transversely at the angle of the jaw. No pus was present, but cultures grew staphylococci. The white blood count was 6,700. Azosulfamide [2] (40 cc. intramuscularly in divided doses) and sulfanilamide (5 grains [0.32 Gm.] every four hours) were given. Twenty-four hours after incision, the swelling of the gland began to subside although respiration was difficult and the patient complained of pain in the back of the neck. On July 20, examination revealed bilateral maxillary sinusitis, more on the right than on the left. The gland swelling rapidly subsided, and the patient was discharged on July 22, six days after entry.

CASE 22 (Firmin Desloge Hospital).—A white man aged 73 entered in December 1937 with the complaint of urinary obstruction with acute retention. Examination revealed a large prostate with urethral obstruction. The patient had also far advanced cardiovascular disease with coronary sclerosis. On December 27, a small swelling occurred in the right parotid gland and was diagnosed as parotiditis. Ice packs were applied. The gland subsided in several days. The patient was found to have diabetes, and treatment was given. During January 1938, the patient had chills and high fever from pyelonephritis and cystitis. The patient was semicomatose. On January 19, the right parotid gland again became swollen and tender, and ice packs were applied. The mouth was dry and coated, and the patient was a constant mouth breather. The duct and pus from the incised gland on culture showed Staph. albus and Staph. aureus. The gland subsided after incision and drainage on the third day after onset. The patient grew gradually weaker and died on the sixth day. The white blood cell count and the fever were high throughout the period of renal infection and so masked the true white blood cell count and fever from the parotiditis. No autopsy was performed.

CASE 23 (Firmin Desloge Hospital).—A white girl aged 13 with previous entries for severe hypertension and nephritis and possible bilateral polycystic kidneys entered on April 10, 1938, with air hunger, edema of the lower extremities

2. Azosulfamide is disodium 4-sulfamidophenyl-2′-azo-7′-acetylamino-1′-hydroxynaphthalene-3′,6′-disulfonate. This substance has been known as prontosil soluble, as prontosil and as neoprontosil.

and hypertension. Examination revealed that there were a blood pressure of 200 systolic and 150 diastolic, a systolic heart murmur, secondary anemia, a nonprotein nitrogen content of 93 mg.; the urine gave a 3 plus reaction for albumin with many white and red blood cells. Retinal examination revealed albuminuric retinitis. The patient gradually became stuporous and drowsy, and on April 28 the nonprotein nitrogen was 347 mg. The patient passed into uremic coma, and anuria developed. The blood pressure fell on May 1 to 134 systolic and 50 diastolic, and swelling of the right parotid developed, gradually becoming larger. The temperature was 100 F. A culture from the right duct on May 3 grew hemolytic gram-positive cocci in clusters and gram-positive rods. On May 3, the right-sided parotiditis had closed the eye. The patient was deeply comatose when she began having convulsions and died fifty hours after the onset of parotiditis. Autopsy revealed swelling in the right parotid area with tense skin and some reddening over the area. There was edema in all tissues with advanced nephrosclerosis.

Case 24 (Firmin Desloge Hospital).—A white woman aged 59 entered on May 9, 1938, with a swelling of the left parotid area. The swelling began two weeks (April 25) before entry without apparent cause. At first, the swelling was soft and only slightly painful, but since then it had grown larger, harder and severely painful. One week after the onset, a sore throat and a cold developed. The pain increased on chewing and was referred to the ear. Examination revealed a swollen, tender, indurated, reddened area at the angle of the left jaw, about 4 by 3 by 2 inches (10 by 8 by 5 cm.) and not fluctuant. No stone was palpable or was seen by roentgen examination of the duct. All teeth had been removed years before. No pus was obtained from the duct. The white blood cell count was 10,000; the temperature was 100.2 F. The urine gave a 3 plus reaction for sugar. The blood sugar was 247. On May 10, with the patient under anesthesia induced with ethylene, a needle was inserted into the gland and pus found, and the gland was then incised, freeing 1 ounce (29.5 cc.) of pus, which on culture grew nonhemolytic streptococci. Moderate drainage continued until May 17, and the swelling rapidly subsided. The patient was treated and instructed regarding her diabetic condition, which was found on entry, and was discharged May 21.

Thirty-two cases accompanying surgical conditions

Case 25 (St. Mary's Hospital).—A white woman aged 29 was operated on Sept. 23, 1924, and a subacutely inflamed gallbladder with stones was removed. On the second postoperative day, a small swelling of the right parotid occurred, and ice packs were applied. The temperature rose from 100 to 101 F. The white blood cell count was 15,800. In twenty-four hours, the left gland was swollen, painful and tender, and ice was applied to both glands. The left gland subsided, but the right gland went on to fluctuation and was incised nineteen days after onset by a vertical incision just anterior to the ear, freeing pus, which on culture yielded staphylococci. The gland drained abundantly, and there was still some drainage when the patient was discharged on October 21, twenty-six days after onset.

Case 26 (St. Mary's Hospital).—A white woman aged 57 was operated on for chronic duodenal ulcer, and a posterior gastroenterostomy was done Sept. 28, 1926. Although apparently adequate fluid was given, the patient complained of marked thirst and pain in her throat on the second postoperative day. In another twenty-four hours (October 1), the right parotid gland was swollen, tender and painful, and the right seventh cranial nerve was paralyzed. Ice packs and oral hygiene were used, but the gland was so swollen that an incision was made. The gland was gangrenous, and there was some pus, which on culture grew Staph. albus.

The white blood cell count was 17,000. The temperature was 102 F. On the fourth day of parotiditis (October 4), the temperature had fallen, but there was black slough at the bottom of the wound. Hot packs were applied. On October 6, there was sloughing of glandular tissue. On the tenth day of parotiditis, the skin wound and much of the gland were necrotic. Two small fluctuant areas were incised and the wound irrigated with diluted solution of sodium hypochlorite (Dakin's solution). On the fourteenth day following incision, the sloughing of skin and the gland was marked. On the eighteenth day after onset, there was extension of the inflammation into the posterior triangle of the neck near the mastoid process, requiring incision two days later. Sodium perborate irrigations were used. On the nineteenth day after the first incision, the patient was up, and there had occurred sloughing of the gland. The patient's temperature ranged from 99 to 101 F. during her convalescence. The patient remained in the hospital three weeks longer, but the wound had not completely healed on discharge. The paralysis remained.

Case 27 (St. Mary's Hospital).—A white woman aged 26 had curettage for retained secundae on March 3, 1927, and uterine suspension on March 7. On March 9, twenty-four hours after operation, the patient complained of pain in the left ear, and several hours later a swelling was noted in the left side of the face. She also complained of difficulty in swallowing. The temperature rose from 99 to 103 F. Ice bags and gargles were used from the onset. By the fourth day, the swelling extended into the neck. The mass was tender, and the skin was edematous and red-blue. The white blood cell count was 25,800. With the patient under anesthesia induced with ethyl chloride, the gland was incised widely by a Y incision, freeing pus and necrotic glandular tissue. A culture grew Staph. albus. Heat was applied to the gland after drainage. Six days after drainage, inability to close the eye and left facial weakness were noted, but these had disappeared in a week. Some time during the course of the infection, pus ruptured into the external auditory canal. There was slight drainage from the gland when the patient was discharged on April 8. Repeated blood cultures were negative.

Case 28 (St. Mary's Hospital).—A white woman aged 55 entered on Aug. 15, 1929, with her left hand swollen to twice the normal size and excruciatingly painful following a pinprick, resulting in tenosynovitis and palmar bursitis. The area of abscess was incised and drained and three days later the tendon sheaths were incised. On August 30, the patient's temperature rose from 100 to 102 F., as a large rapidly increasing inflammatory swelling occurred in the left parotid area and the neck. The white blood cell count was 16,000. Oral hygiene was satisfactory. The enlargement of the parotid increased in the next twenty-four hours, and a swollen edematous gland was opened by an incision below the ear and forward parallel with the mandible for 2 inches (5 cm.). The gland later drained pus profusely and decreased in size, but the wound was still draining when the patient was discharged.

Case 29 (St. Mary's Hospital).—A white man aged 23 known to have diabetes entered on May 5, 1933, with a blood sugar content of 333 mg. and peritonitis and a large mass in the right lower quadrant of the abdomen. The white blood cell count was 17,700. The patient was operated on; a ruptured appendix was removed, and an abscess was drained. On May 8, the third postoperative day, a painful swelling occurred at the angle of the right jaw, and ice packs and oral hygiene were instituted. In twenty-four hours, the swelling had increased markedly, was tender and painful and caused stiffness of the neck. The temperature was 102.6 F. After forty-eight hours, the gland was drained by an incision below

the ear and along the mandible, where the swelling was greatest. No pus was found. On May 11, the third day of parotiditis, there was edema of the entire right side of the face and both eyelids, and on the fourth day, the uvula was edematous. Thereafter, the inflammation rapidly subsided, and the patient was discharged on June 3 with the wound practically healed. The parotid was less responsible for the delayed discharge than the draining abdominal wound.

Case 30 (St. Mary's Hospital).—A white woman aged 53 was operated on on Sept. 26, 1933. Appendectomy and hysterectomy were done. On the tenth day after operation, parotiditis developed rapidly on the right side. The white blood cell count was 36,600. The temperature was 101.4 F. After twenty-four hours, the gland was incised and drained, but no pus was found. Within two days, the parotiditis had subsided. The white blood cell count was 12,600. The temperature was 103 F. A blood culture was negative. On the sixth day, the patient's temperature was normal. A week after the parotiditis had subsided, the abdominal wound was opened and drained urine. The patient later recovered entirely.

Case 31 (Firmin Desloge Hospital).—A white woman aged 36 entered on Nov. 26, 1933, and on December 9, at operation, a ruptured ectopic pregnancy was found. On the fifth postoperative day, a swelling developed in the left parotid, which rapidly involved the whole gland, with pain in the ear, and the temperature rose to 102 F. In forty-eight hours, a small incision was made below the left ear, freeing pus which cultured Staph. albus. The white blood cell count was 12,000. The same evening, the patient complained of pain and tightness in the throat with inability to open the mouth. The gland remained swollen, and hot packs were applied. Five days after the first incision, the gland was reincised by an inverted T incision, opening an extracapsular and intracapsular abscess which had burrowed back to the external auditory canal. The neck of the mandible was surrounded by an abscess cavity containing 3 ounces (88.7 cc.) of pus. There was also a hard phlegmon of the gland along the head of the mandible and behind the ear. During the operation, the abscess ruptured into the mouth. The temperature was 101 F. There were abundant drainage from the incisions and marked sloughing of the gland followed by seventh nerve paralysis. On Jan. 7, 1934, an abscess was found on the anterior part of the gland and was incised the next day. The patient complained of severe headache and occipital pain on the same side as the parotiditis. Pus was draining from the ear, both from the parotid extension and from suppurative otitis media. The patient continued to complain of terrific pain in the head, and temporal abscess was suspected. On January 27, a prominence of the eyes was noted, more on the right than on the left. On January 28, the right eye was protruding, and the patient was complaining of photophobia and occipital pain. After three days, the temperature was 103.8 F., and the patient became irrational and incoherent. The patient was operated on for disease of the mastoid, and acute purulent infection was found in the mastoid. The patient died fourteen hours later. Autopsy revealed acute purulent sphenoid and ethmoid sinusitis, otitis media, cavernous sinus thrombosis, septic pneumonia and septic necroses in the liver and the kidneys. The necrotic wound of the parotid showed pus deep in the cavity, and palpation revealed the bare temporomandibular joint and an abscess cavity extending upward and medial to the mandible.

Case 32 (St. Mary's Hospital).—A white woman aged 23 had her tonsils removed on Aug. 15, 1934. This was followed five days later by a swelling in the parotid on the left. On entry, August 26, the patient complained of pain in the throat and of a large, red, hot, painful, nonfluctuant swelling of the left parotid.

The patient could not open her mouth. Ice packs were applied and fluids forced until August 30, ten days after the swelling started, and then with the patient under local anesthesia the gland was incised by a vertical incision in front of the ear, freeing yellow pus. Four days later there was rupture of pus into the external auditory canal. The edema and swelling rapidly subsided, but the patient complained of pain and swelling in her throat, and on September 14, two weeks after the gland was drained, a peritonsillar abscess was opened and an impacted molar tooth extracted. The patient was discharged on September 19, twenty-three days after entry.

Case 33 (St. Mary's Hospital).—A white woman aged 31 entered for cholecystectomy. This was done on Dec. 5, 1934. On the sixth postoperative day, the patient complained of dryness of the mouth and pain in the right parotid, which rapidly became swollen, red and tender. The white blood cell count was 19,700. The temperature was 100.2 F. In three days there was increased swelling, and the skin of the right side of the face was tense. The gland was tender but not fluctuant. The duct was slightly red and swollen, with a drop of pus at the orifice; cultures of the pus grew Staph. albus and small gram-positive rods. The gland was incised under local anesthesia by a vertical incision, freeing no pus but, on culture, growing Staph. albus. Hot packs replaced the ice which had been applied to the gland. The white blood cell count was 33,000. There was gradual improvement and abundant purulent drainage in forty-eight hours. The patient was discharged December 30, sixteen days after the onset of parotiditis.

Case 34 (Firmin Desloge Hospital).—A young white man aged 18 was struck on the side of the face by a fist; this was followed forty-eight hours later by a rapidly developing swelling of the face, the cheek and the upper part of the neck. On entry, Nov. 1, 1934, twelve days after injury, the condition was diagnosed as fracture of the mandible and parotid abscess on the left. The area was red, hot and tender with generalized swelling of the left cheek and extension of the swelling into the neck. The overlying skin was tense, smooth and shiny. The white blood cell count was 14,000. The temperature was 102 F. Soon after entry, with the patient under anesthesia induced with nitrous oxide, the abscess of the parotid was opened by a 2 inch (5 cm.) incision along the ramus of the mandible, and a rubber dam drain was inserted. A large amount of pus, white in color and foul in odor, was freed. Smears made from the pus showed organisms of Vincent. Hot wet packs were applied to the wound, and the temperature fell to normal within twenty-four hours. The patient was discharged ten days after the incision of the gland.

Case 35 (Firmin Desloge Hospital).—A white man aged 70 years entered Nov. 21, 1934, for fulguration of a squamous cell carcinoma on the right side of the hard palate. Extensive fulguration was done, including the soft palate, and nasal tube and intravenous feeding was necessary. Because of unhealthy gums and teeth, mouthwash was used frequently. Five days after operation, November 27, bilateral swelling appeared in the parotid region, more on the left than on the right, and ice packs were applied. The swelling of the left gland continued to increase, and after seven days, with the patient under local anesthesia, an abscess of the left parotid was opened by an incision 2 inches (5 cm.) long below and parallel to the body of the mandible. Culture from the wound grew gram-positive cocci. The left parotid subsided after the incision. Sixteen days after the swelling first appeared in the left gland, the right gland became markedly swollen and was incised the following day by a 1 inch (2.5 cm.)

incision obliquely placed behind the angle of the jaw. The capsule was opened, freeing thick yellow pus, which on culture grew gram-positive cocci in clusters. In one month, the left parotid was healed, and the right had subsided. The patient was discharged on December 23.

Case 36 (Firmin Desloge Hospital).—A white woman aged 44 with uterine carcinoma, carious teeth, pyorrhea alveolaris and pharyngitis was operated on. A radical Wertheim procedure was done. Six days after operation, a small stitch abscess was opened. The patient had a chill. The temperature was 103.6 F. The white blood cell count was 25,000. Cystoscopic examination showed cystitis and pyelitis. A culture of the abdominal wound showed gram-positive cocci in clusters and Bacillus coli. On forced fluids, transfusions and sustaining treatment, the patient improved. On Oct. 18, 1936, the twenty-second postoperative day, the patient noticed a tender swelling below the right ear and behind the angle of the jaw. The temperature rose from 99.8 to 101.2 F. In twenty-four hours, the swelling had greatly increased and was painful and tender. The papilla was red and elevated, but no pus could be expressed from the duct. Ice packs, oral hygiene and chewing gum were given. On the third day, with the patient under anesthesia induced with ethylene, a 3 inch (7.6 cm.) vertical incision was made just anterior to the ear. No pus was found, but cultures grew gram-positive cocci and gram-negative rods. Blood cultures were negative. In two days, the gland swelling subsided. In twelve days, the temperature and the white blood cell count were normal, and the gland was healing. The wound was entirely healed on the twenty-sixth day.

Case 37 (St. Mary's Hospital).—A white woman aged 59 had a panhysterectomy done for carcinoma of the cervix on March 23, 1936. On the sixth postoperative day, the left parotid became enlarged. Ice packs were applied, but in twenty-four hours, the swelling had increased, and the right parotid was beginning to swell also. The temperature was 100 F. The white blood cell count was 21,500. Oral hygiene was given. The pain was severe and the swelling marked, but the right gland was subsiding on the third day (April 1). The left gland was drained by a small incision with the patient under local anesthesia, and the swelling gradually subsided. Discharge from the gland was slight, and the gland was healing by April 3. On April 14, seventeen days after the onset, a reddened area appeared at the left ear, became fluctuant and was incised on April 16. Recovery was gradual, and the patient was discharged on May 18.

Case 38 (St. Mary's Hospital).—A white woman aged 45 was operated on for fibromyoma of the uterus on April 3, 1936. On April 7, signs of peritonitis developed, and the wound on culture gave a growth of streptococcus. The same day, a firm swelling developed in the parotid, not red or tender. The white blood cell count was 9,500. The temperature was 103 to 104.5 F. The condition was diagnosed as acute peritonitis and secondary parotiditis. Within twenty-four hours, the gland was incised, but no pus was found, although cultures showed staphylococci. The urine showed albumin and red cells. Peritonitis was progressive, and the patient died on April 10. The gland swelling had subsided before death. No autopsy was done.

Case 39 (St. Mary's Hospital).—A white woman aged 46 was operated on June 16, 1936. Total hysterectomy, oopherectomy and appendectomy were done. After seven days, the white blood cell count was 20,000. The temperature was 102 F. An abscess of the abdominal wound was opened, and cultures grew gram-negative cocci and bacilli and gram-positive cocci. On June 27, the eleventh post-

operative day, parotiditis began on the left side at the angle of the jaw, and the swelling occurred so rapidly that in twelve hours the whole side of the face and the upper part of the neck were involved—there was even edema of the eyelids. Ice packs, lemon juice, chewing gum and gargles were given. The gland was exquisitely tender. In twenty-four hours, the edema of the eyelids was marked, and the skin of the left side of the face was red, brawny and edematous. On June 28, with the patient under general anesthesia, the gland was opened; it was black and gangrenous. Culture showed Staph. aureus. Blood cultures were negative. Hot boric acid packs were applied. The next day, the edges of the wound were necrotic; the gland was a dirty gray color, and the patient was growing weaker. In the next four days, the swelling slowly decreased, and pus began draining through the ear on July 3. The temperature was 102 F. On July 4, a pelvic abscess was opened through the vagina. Thirty minutes after opening the pelvic abscess, the patient suddenly died. No autopsy was performed.

Case 40 (St. Mary's Hospital).—A white woman aged 85 entered on Aug. 9, 1936, in a critical condition with pain and a mass in the right upper quadrant of the abdomen present for five days before entry. The white blood cell count was 30,000. The temperature was 101 F. The patient was treated conservatively until August 15. With the patient under local anesthesia, acute empyema of the gallbladder with stones and local peritonitis was drained. A culture of the gallbladder grew B. coli. The same evening, the left parotid began to enlarge and in a few hours involved the side of the face and the neck. Previous to operation, little fluid had been taken per os, the patient receiving fluids parenterally. After twenty-four hours, with the patient under local anesthesia, the left gland was opened by a vertical incision anterior to the ear. The gland was necrotic and green-gray. Three days after the onset of parotiditis, the patient complained of difficult swallowing and sore throat, and a swelling of the right submaxillary gland was noted but gradually subsided in three days. The left parotid gradually decreased in size, but the patient grew weaker, and cardiac failure and auricular fibrillation developed. The patient died on August 27, eleven days after the onset of parotiditis. No autopsy was done.

Case 41 (St. Mary's Hospital).—A white woman aged 50 had mastoidectomy on the left on Sept. 2, 1936. On September 14, a rapidly increasing swelling occurred at the angle of the left jaw, and a slight enlargement of the right parotid also appeared. On entry, September 15, the left gland was firm, tender, nonfluctuant and painful, especially on opening the mouth. The temperature was 100.6 F. The white blood cell count was 11,900. Ice packs were applied to both glands, and the swelling decreased in four days. When the patient could open her mouth, carious teeth, injection of the pharynx and poor oral hygiene were noted. The patient was discharged on September 20, six days after onset of parotiditis.

Case 42 (Firmin Desloge Hospital).—A white woman aged 26 had the right lower first molar extracted, and three days later, on Feb. 9, 1936, swelling began in the right parotid area just anterior to the ear and rapidly increased until the patient could open her mouth to the extent of only 1 cm. When she entered on February 18, nine days after onset, the swelling was painful and tender, extending from the zygoma to 1 inch (2.5 cm.) below the angle of the jaw and 2 inches (5 cm.) anterior to the ear with the skin brawny and edematous. The gums were covered with a white membrane which left a bleeding area when removed. The duct was not red or elevated. The temperature was 103 F. The white blood

cell count was 17,500. In twenty-four hours, the right eye was entirely closed by swelling and edema, which extended also several inches below the angle of the mandible. Smears from the gums showed no spirilla. In another twenty-four hours, the right side of the face drooped from facial nerve weakness, and respiration and swallowing were difficult. On March 1, twenty-one days after onset, the gland was incised from below the ear forward, freeing a large amount of pus, foul smelling but growing no organisms when cultured, although the right duct on culture now yielded a growth of fusiform bacilli. The abscess had almost completely destroyed the gland and extended into the retromandibular space. Hot packs were applied. The swelling decreased, and the fever fell to 101 F., but forty-eight hours after incision the temperature rose to 105.6 F., and there was evident extension down into the anterior and posterior triangles of the neck. There was extensive necrosis deep in the wound. Diluted solution of sodium hypochlorite (Dakin's solution) was used for irrigation on the fifth day. The white blood cell count was 27,000. Septic fever was present with a temperature as high as 106.5 F. On the sixth day, March 7, a 2 inch (5 cm.) incision was made above the clavicle, freeing a large amount of foul pus from a cavity beneath the cervical fascia. The patient was toxic and weak. Transfusions were given. On March 9, eight days after the gland was first incised, a moderate second degree hemorrhage occurred in the retromandibular space. The patient died on March 10. All blood cultures were negative. No autopsy was done.

Such a history does not reflect credit, but it must be taught that when acute surgical parotiditis develops, it requires the services of a properly qualified surgeon.

CASE 43 (Firmin Desloge Hospital).—A white woman aged 48 had cholecystectomy and appendectomy done on June 15, 1936. On the third postoperative day, the temperature rose to 101 F., and swelling began in the regions of both parotids. The patient had been on a liquid diet for some days. In twenty-four hours, the temperature rose to 104 F., and the right gland increased in size rapidly, involving the face and the neck to such an extent that dyspnea was marked, and a tracheotomy tube was kept in the room. The white blood cell count was 19,000. The left parotid also was hard and edematous. Forty hours after onset, on June 20, with the patient under local anesthesia, a 2 inch (5 cm.) incision was made bilaterally, extending from the tragus down and forward over the gland. Culture of the gland showed Staph. aureus. There was no pus. Difficulty on swallowing and swelling of the gland continued until June 26, when pus ruptured into the right external auditory canal, and then the swelling and the fever subsided. Within four days, all symptoms had subsided. The parotid wounds were healing when the patient was discharged on July 15, on the twenty-seventh day after the onset of parotiditis.

CASE 44 (Firmin Desloge Hospital).—A white man aged 31 was operated on July 18, 1936 for what was thought to be a perforated gangrenous appendix (later it proved to be a perforated cecal diverticulum), and a large abscess cavity was drained. On July 21, the third postoperative day, the right parotid gland became swollen. The temperature rose from 101 to 104 F. Ice packs were applied, and oral hygiene was given, but the swelling increased and within forty-eight hours extended to the clavicle and was exquisitely tender. The white blood cell count was 21,000. The patient had chills. The gland was opened by a linear incision in front of the ear and at the angle of the jaw, freeing a bloody fluid. A culture

of the gland was negative, and a blood culture was negative. On the third day, the parotid and the cervical fascia were divided because of extreme swelling. The swelling decreased, and by July 25 (the fourth day) there was abundant purulent drainage, which on culture gave a growth of Staph. aureus and Staph. albus. The temperature was 102.5 F. Rales were present in the lungs. By July 27, the swelling had increased to almost midline and 2 inches (5 cm.) below the clavicle. Incision was made below the clavicle, draining a pocket of pus. Pus had burrowed back to the mastoid and along the mandible to the midline. On July 28, the anterior triangle of the neck was opened widely, and the jugular vein was ligated. The swelling had increased to the point that breathing was difficult. Following a transfusion, the patient had a chill, and the temperature rose to 106.4 F. He died two hours later. Autopsy revealed red, edematous swelling of the entire right side of the face and the neck with pitting edema. Septic pneumonia and general toxic changes in all viscera were present.

Case 45 (Firmin Desloge Hospital).—A white woman aged 71 with marked arteriosclerosis and hypertension and inoperable carcinoma of the sigmoid colon had a colostomy done July 31, 1936. Fluids were not withheld, and mouthwash was frequently given. On the fourth postoperative day, the right parotid began to swell, becoming red, firm and tender, painful and hot. The white blood cell count was 20,000. The temperature was 100 F. Within twenty-four hours, with the patient under general anesthesia, the gland was drained by a vertical incision anterior to the ear. The gland was red and edematous and on culture grew Staph. aureus, but no pus was present in the gland. Hot packs were applied. On the second day of parotiditis, respiration was difficult, and the patient was weak. Signs of acute cardiac failure developed rapidly. On the fourth day, the right gland was subsiding when swelling of the left gland occurred and advanced so rapidly that within twenty-four hours the entire left side of the face and the neck was involved. Respiration was so difficult that a tracheotomy set was kept in readiness. A wide incision was made from the zygoma to well below the mandible, just anterior to the ear. The patient became comatose and died on August 8, on the fourth day of parotiditis and eight days after operation. No autopsy was done.

Case 46 (Firmin Desloge Hospital).—A white man aged 24 entered with a history of no bowel movements in seven days and with a rigid silent abdomen and picture of marked toxicity. At operation a ruptured appendix was removed. General peritonitis was present and, in addition, there were five points of obstruction of the small bowel and volvulus of the entire small intestine and its mesentery. One area of the ileum was gangrenous and was brought on the surface of the abdomen. The patient went into shock but recovered. Subsequently, he recovered sufficiently for repair of the ileostomy and resection of a portion of the small bowel. This was done on Dec. 16, 1936, two months after the first operation. On the third day after this operation, swelling occurred in both parotids, and ice packs were applied. The swelling increased rapidly on the right and soon extended from the zygoma to below the angle of the jaw and 2 inches (5 cm.) anterior to the ear. Both parotids were tender, but the right was brawny, and the overlying skin was tense and shiny. Cultures of the right duct showed Staph. aureus and gram-positive rods, and cultures of the left duct, Staph. aureus. The white blood cell count was 13,000. The temperature was 99.6 F. After twenty-four hours, the right gland was opened widely by a vertical incision with the patient under local anesthesia. No pus was found, but the gland was acutely inflamed. The left gland increased in size but gradually subsided under ice packs and azosulfamide.

In eight days both glands were back to normal size, and the right parotid was healing when the patient was discharged on Jan. 7, 1937, three weeks after onset of parotiditis.

Case 47 (Firmin Desloge Hospital).—A white woman aged 61 with pyloric obstruction due to carcinoma of the stomach had a gastroenterostomy done on Nov. 16, 1936. The patient insisted on wearing her dentures after operation and it was difficult to maintain good oral hygiene. On the fifth postoperative day, November 21, the patient's temperature rose from 99 to 101 F., and a swelling appeared at the angle of the left jaw. Ice packs were applied to the gland, and lemon juice, chewing gum and gargles were given. The swelling increased slowly, and by the third day it was 2 by 2 inches (5 by 5 cm.), lying beneath the ear and on the mandible at the angle. The duct was normal. In another thirty-six hours, on November 26, the swelling extended from the zygoma to 2 inches (5 cm.) below the mandible and from the mastoid to 2 inches (5 cm.) anterior to the ear, with brawny edema of the area. The white blood cell count was 10,000. On November 27, the gland was tense and red but not fluctuant, and it was incised with the patient under local anesthesia by a vertical incision anterior to the ear and a short horizontal incision along the ramus of the mandible. The gland was red-brown and showed marked inflammatory edema, but no pus was present. At this time (sixth day), pus was exuding from the duct on pressure on the gland. Cultures of the duct and the gland gave a growth of staphylococcus. The white blood cell count was 17,000. As the gland began draining pus, the edema and the inflammation subsided, and a facial weakness present for several days before incision gradually disappeared. The gland drained a week, when a tender painful swelling occurred at the mastoid, and pus was draining from the external auditory meatus. The small abscess beneath the ear in the mastoid area was incised, and about 10 cc. of pus was evacuated. Both wounds healed by granulation, and the patient was discharged on December 16, three weeks and four days after the onset of parotiditis.

Case 48 (St. Mary's Hospital).—A white man aged 28, entered in shock and was operated on for perforated gastric ulcer on Nov. 16, 1936. Perforation had occurred nearly twenty-four hours before entry, and general peritonitis was present. Oral fluids were given regularly. On the ninth postoperative day, the white blood cell count was 14,500. The temperature was 102 F. A small swelling appeared at the angle of the left jaw just below the ear; the area was red, firm and tender. Ice packs were applied, and mouthwash, lemon juice and potassium iodide (15 grains [0.97 Gm.] three times per day) were given. The following day, the patient felt secretion passing into his mouth on the left side, relieving the pain and decreasing the mass slightly. The duct papilla was red and edematous, and there was dirty gray coating on the teeth and gums. Culture from the left duct grew gram-positive cocci and rods and gram-negative rods. The gland enlarged, and hot packs were applied. A 30 per cent erythema skin dose of roentgen radiation was given to the left gland on December 1, five days after the onset of parotiditis. Pus was draining from the ear and through an opening in the anterior wall of the external auditory canal. The pus when cultured yielded a growth of Staph. aureus. Blood cultures were negative. On the sixth day, the gland was incised and drained of pus which on culture gave Staph. aureus. The swelling and the drainage subsided, and the temperature dropped from 103 to 99 F. in a week. On December 9, two weeks after the onset of parotiditis on the left, a swelling of the right submaxillary gland was noted. The submaxillary became fluctuant after nine days, and the gland was incised on December 18. On December

22, the patient was operated on for intestinal obstruction due to massive peritoneal adhesions, and when reobstruction occurred on December 26, a Witzel enterostomy was done. The parotid and the submaxillary glands were entirely healed before the second operation for obstruction. The patient continued to grow weaker and died on Jan. 22, 1937, nearly two months after the onset of parotiditis. Autopsy showed gangrene and multiple perforation of the small bowel with multiple abscesses.

CASE 49 (Firmin Desloge Hospital).—A white man aged 33 with untreated diabetes mellitus and bilateral apical tuberculosis had the right lower second molar tooth extracted on Dec. 20, 1936. Six days later a gradual swelling, painful and tender, developed in the right parotid area. Three days later, the patient had a chill, and he had difficulty in swallowing and opening his mouth due to the brawny swelling. The patient entered on December 31, the fifth day of parotiditis, with a red tender fluctuant swelling of the right parotid extending from the zygoma to 3 cm. below the angle of the mandible. The blood sugar was 365 mg. The white blood cell count was 14,700. The temperature was 99.2 F. The gland was drained soon after entry through a 2 inch (5 cm.) incision vertically and just anterior to the ear, and a 2 inch (5 cm.) incision at the angle of the jaw, freeing 30 cc. of foul pus. Oral hygiene and hot packs were used, and the gland drained freely. Blood and wound cultures were negative. The patient was discharged to the clinic with an unhealed wound on Jan. 15, 1937, three weeks after onset.

CASE 50 (St. Mary's Hospital).—A white woman aged 33 had a criminal abortion performed by a midwife on Dec. 4, 1936, and was well until December 19, when symptoms of peritonitis developed. The patient entered the hospital on December 22 with a rigid tender abdomen. On December 29, the white blood cell count was 10,500. The temperature was 99.6 F. A swelling began in the right parotid followed soon by an enlargement of the left gland. The temperature rose to 101.2 F. In twenty-four hours there was marked increase in the swelling with the left side edematous to the eyelids but the right side more brawny, edematous and painful. A 30 per cent erythema skin dose of roentgen radiation was given to the right gland on December 31. The left gland subsided without further interference. Azosulfamide was given seventy-two hours after the onset of parotiditis, and a second roentgen treatment was given on Jan. 2, 1937. The white blood cell count was 22,000. On January 4, the twelfth day of parotiditis, there was fluctuation at the level of the angle of the mandible, and with the patient under local anesthesia a wide Y incision was made, freeing pus from an abscess at the lower pole of the right gland. The gland was black and necrotic; cultures from it grew Staph. aureus. After two weeks, the inflammation had subsided, and secondary closure of the incision was made. The patient was discharged on January 26.

CASE 51 (St. Mary's Hospital).—A white woman aged 47 entered with signs of peritonitis and paralytic ileus and was operated on for a ruptured diverticulum of the colon with abscess. A stormy postoperative course followed with the occurrence of fecal fistula. One month after the operation, a tender hard mass developed in the right parotid area and rapidly became swollen and brawny. The mouth was dirty with several badly decayed teeth. After twenty-four hours, the gland was opened by a vertical 2 inch (5 cm.) incision in front of the ear. No pus was present, but the culture grew staphylococcus. The gland drained several weeks, during which a psychosis developed, and the wound was healed by Oct. 10, 1937, four weeks after the onset of parotiditis.

CASE 52 (St. Mary's Hospital).—A white man aged 30 entered and was operated on Sept. 18, 1937, a ruptured appendix being removed and diffuse purulent peritonitis drained. Culture of the wound yielded gram-positive cocci and rods and gram-negative rods. On the fourth postoperative day, a sensitive swelling began in front of and just below the right ear. The patient was weak and toxic following operation and mentally dull. The temperature was 104 F. Ice packs were applied, and oral hygiene was given. By the sixth day of parotiditis, the swelling had extended into the neck, and the patient had difficulty opening his mouth. The white blood cell count was 9,900. On September 30, the eighth day, with the patient under local anesthesia, an extensive Y incision was made, freeing much pus and revealing a necrotic gland with a sinus extending into the external auditory meatus. A culture of the gland grew Staph. aureus. Hot packs were applied. The patient continued on a downward course and was irrational and weak. The white blood cell count dropped to 2,700. The patient died on October 8. No autopsy was performed.

CASE 53 (Firmin Desloge Hospital).—A white woman aged 46 entered Sept. 12, 1937, with a fluctuant swelling of the left parotid area diagnosed as parotid abscess. A small stone was palpable in the left parotid duct. The patient gave a history of previous swelling of the gland; this had subsided some months before entry. Six days before the patient came to the hospital, a painful enlargement of the left parotid began. Soon after onset, the patient noticed yellow semipurulent discharge in the region of the duct and found that the flow was increased by applying pressure on the parotid swelling. On entry, six days after the onset, the bulging left parotid area was firm, brawny and painful but not red, and the swelling extended from the lobe of the ear to the angle of the mouth and from the zygoma to below the mandible. There was some sign of fluctuation. The temperature was 103 F. The white blood cell count was 15,750. The papilla of the left parotid was red and edematous, and cultures of it grew gram-positive rods.

On the day of entry, the gland was drained by a 1½ inch (3.8 cm.) curved incision just anterior to the ear, and the capsule was opened, freeing 12 cc. of yellow foul-odored pus. The duct was incised, and a hard yellow stone about 3 mm. in diameter was removed. A rubber dam drain was used in the gland. Hot saline packs were applied to the gland, and mouthwash was given. Cultures from the gland grew large gram-positive rods, gram-negative rods and diplococci. A blood culture was negative.

After four days there was still profuse drainage, but the swelling had extended to the mastoid region with marked tenderness but no fluctuation in the area. On the sixth day after entry, September 18, the gland was reopened, carrying the first incision down and back under the ear, opening a large multilocular abscess. Culture showed the organisms of Vincent's infection, and the patient was given two doses of neoarsphenamine (0.3 Gm., three days apart). The discharge and the swelling decreased; the temperature fell, and the white blood cell count gradually returned to normal. The patient was discharged on the eighteenth day after entry, September 30.

CASE 54 (Firmin Desloge Hospital).—A white woman aged 61 with multiple fibromyoma of the uterus and carcinoma of the rectum was operated on on Nov. 19, 1937, and supravaginal hysterectomy and sigmoid colostomy were done preparatory to the removal of a rectal carcinoma. On the fourth day after hysterectomy and colostomy, a swelling appeared at the right parotid area, extending below the mandible, with red and firm overlying skin. The temperature was 102.5 F. The white blood cell count was 17,000. In twenty-four hours, the gland was greatly

swollen, carrying the ear outward from the side of the head. The duct was red and edematous, with a drop of pus at the orifice; the mouth was dry, and the teeth were dirty and carious. The gums were dirty and spongy, and the breath was foul. Ice packs were applied, and oral hygiene was given. Signs of peritonitis developed on the fifth postoperative day, and the temperature rose to 103 F. Cardiac fibrillation began. Blood cultures were negative, and a duct culture grew staphylococcus. The gland was subsiding when the patient passed into coma and died on the sixth postoperative day and the third day of parotiditis. No autopsy was performed.

CASE 55 (St. Mary's Hospital).—A Hawaiian-Chinese woman aged 23 entered May 12, 1938, with severe headache and pain in the right lower quadrant of the abdomen accompanied by nausea. The white blood cell count was 21,000, with 3 juvenile forms, 18 stab forms, 59 neutrophils and 20 lymphocytes. The blood chemistry and the hematologic findings were otherwise negative. With the patient under spinal anesthesia on the day of entry, the abdomen was explored and appendectomy done. The bowel and the peritoneum were red, and there was an odorless exudate present. The appendix showed catarrhal appendicitis. The abdomen was drained, and cultures from the exudate at operation were negative. On the third postoperative day, a blood culture grew hemolytic streptococci, and a pure growth of hemolytic streptococci was cultured from the drainage from the abdomen. The patient's temperature was 103 F. Fluids were forced intravenously, and antistreptococcic serum and antierysipelas serum was given. The patient was making gradual recovery until May 25, when she complained of pain in the left jaw; examination revealed a lower third molar cutting through the gum. The pain was attributed to this, but on the following day, May 26, a tender, tense and painful swelling developed in the left parotid. Ice bags were applied, and chewing gum was given. On May 27, the area was inflamed, and the papilla was inflamed with a deposit of flaky material around it. The temperature was 101.4 F. per rectum. The white blood cell count was 20,000. On May 28 the swelling continued, and ice packs were changed to hot boric acid packs. Culture made from the papilla grew nonhemolytic streptococci and Staph. aureus. The left gland was incised on May 28, and the whole gland was seminecrotic with an abscess behind the neck of the mandible, containing yellow odorless pus, which, on culture, grew Staph. aureus. Culture of the abdominal wound at this time yielded B. coli. After incision, hot wet 2 per cent saline packs were used. The temperature May 28 was 103.2 F. and by May 30 was only 100.6 F. per rectum. The gland continued moderate purulent drainage for three weeks and was irrigated with hydrogen peroxide and solution of sodium chloride until June 12. On July 28 there was thick purulent discharge from the left ear; this was diagnosed as otitis media. On August 4, acute hemorrhagic nephritis developed, and frequent transfusions were given. The patient recovered sufficiently to be discharged on September 25. At the time of writing, she remains well.

CASE 56 (St. Mary's Hospital).—A white woman aged 25 entered Nov. 19, 1938, with acute pain, nausea and vomiting diagnosed as acute cholecystitis with lithiasis. She was treated conservatively, and operation was deferred until December 5 because severe sinusitis, pharyngitis and bronchitis developed. On December 5, with the patient under spinal anesthesia, an acute subsiding inflamed gallbladder with stones was removed. On December 7, on the second postoperative night, the patient began to complain of pain in the jaw, and ice bags were applied. On December 8, a swelling began in the right parotid. Chewing gum and cleansing mouthwash were given. There was continued swelling of the gland, and the

temperature was up from 99 to 101.2 F. On December 9, the patient complained of pain and fulness in the throat. The temperature was 101.6 F. With the patient under anesthesia induced with cyclopropane, the gland was incised by a Y incision. The gland was found to be swollen, edematous and filled with a cloudy exudate which on culture yielded Staph. aureus. Sulfanilamide was given (30 grains [1.94 Gm.] daily for two days). On December 12, the face was still swollen on the right, and a slight swelling was beginning in the left parotid. The swelling on the left increased for two days and then subsided. On December 15, there was still swelling of the right gland and a small amount of discharge, but the temperature was normal. The remainder of the recovery was uneventful, and the patient was discharged on December 23.

TABLE 1.—*Age Incidence of Acute Surgical Parotiditis*

	Decade								
	1	2	3	4	5	6	7	8	Total
Cases	1	2	15	6	11	9	5	4	56

TABLE 2.—*Incidence of Acute Surgical Parotiditis in Relation to Monthly Admissions* *

	Admissions to Medical Services	Cases of Parotiditis	Admissions to Surgical Services	Cases of Parotiditis
January	2,301	6	2,557	0
February	2,189	0	2,688	1
March	2,489	2	2,599	2
April	2,272	2	2,578	1
May	2,218	1	2,876	2
June	2,503	1	2,844	2
July	2,442	3	2,852	1
August	2,606	1	2,624	4
September	2,585	3	2,689	6
October	2,323	1	2,737	3
November	2,236	3	2,602	5
December	2,308	1	2,239	5

* In these figures admissions to eye, ear, nose and throat, obstetric and newborn services are omitted.

CAUSATIVE FACTORS

Sex.—Most of our patients were females. In the medical services there were 12 of each sex, but in the surgical services there were 23 women to 12 men. The disease attacked 17 women following abdominal operations, and of these, 8 had operation for gynecologic conditions (1 in every 400 gynecologic operations).

Age.—Our youngest patient was a girl of 9 years (case 9), and our oldest was a man of 87 (case 14). The disease has been reported in infants by Brandt. Table 1 shows the age incidence in our series.

Month of Occurrence.—Table 2 shows the incidence of the disease from 1926 to 1939 in relation to services, admissions and months of the year.

Table 3 shows the occurrence by years.

One will note the greater numbers during the last few years. This is partly due to the facts that our hospital population was almost doubled by the addition of Firmin Desloge Hospital and that there has been an increase in the number of patients at St. Mary's Hospital. The large number for 1936, almost one third of all the cases, perhaps shows the causative influence of weather. In that year occurred the hottest summer ever recorded in St. Louis, and 45 per cent of the cases for that year occurred during its three hottest months. The incidence that year was 1 in 647 in contrast with the ordinary incidence of 1 in 2,167. This is in agreement with the observations of Cope.

The admissions for the last half of the year are slightly more than those for the first half, viz., 50.07 per cent, but 64.2 per cent of our cases occurred in the last six months of the year. In the surgical service only 25 per cent of our cases occurred in the first half of the year, while in the same time we received 56.25 per cent of our patients, whereas in the medical service 50 per cent occurred in each half, and the admissions

TABLE 3.—*Occurrence of Acute Surgical Parotiditis by Years*

Year.....	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
Cases.....	1	0	1	0	2	5	0	0	2	5	6	4	17	8	5

were nearly the same for each half year (13,972 and 14,490). It will be seen that 25 per cent of all the cases occurred in August and September, but November and December contributed the same percentage of cases. And while September was the month most fruitful in the number of cases (16.1 per cent), November was but 1 case behind with 14 per cent of the total. While one is wondering whether after all the weather has anything to do with the condition, we refer again to the hottest year of all, 1936, with its quota of 30.3 per cent of all our cases and to Cope, whose experience was similar to ours.

Vascular Conditions.—In 11 patients (cases 3, 6, 7, 9, 13, 14, 15, 17, 18, 23 and 45), 20 per cent of all, advanced arteriovascular renal disease was present in some form, with or without hypertension, nephrosclerosis, uremia or coronary disease. In 2 of these, it is doubtful whether the parotiditis was a causative factor in the outcome.

Diabetes.—In 5 patients (cases 2, 5, 22, 29 and 49) who had diabetes, parotiditis developed. Of these, 2 were in coma when they were brought in.

Condition of Mouth.—In the reports of 25 of the 56 cases, specific mention is made of the condition of the mouth, and in all, one finds repeated the words "pyorrhea," "caries," "dry," "dirty" or "foul." In

none is mention made that the mouth was in a clean or sanitary condition. Besides this, it should be remembered that another 7 of our cases occurred in those who were being nourished parenterally; in cases in which this type of nourishment is carried out, it is the rule to find the mouth more or less dry. Fenwick called attention to this in 1909 and suggested putting a rubber teat or pebble or a bit of raw meat or horse radish in the mouth to make the saliva flow in order to prevent infection of the gland.

Respiratory Tract.—Seven cases of parotiditis appeared in which there were pharyngitis and infection of the respiratory tract, but of these, only one occurred with bronchopneumonia, one during and one after lobar pneumonia—all primary. We call attention to this because the statement has been frequently made (and more frequently copied) that the condition most often follows pneumonia.

Stone.—Only 1 case was due to stone in the duct.

Ear, Nose and Throat.—The condition has been said not to appear after mouth and throat infections, but 2 of our cases followed tonsillectomy, and 2 followed tooth extractions; 1 followed fracture of the adjacent mandible; 2 of our patients had otitis media, and 1 had a mastoid operation. There were 4 cases in which no cause could be given. This was remarked long ago by Carr and Day and has been confirmed by Nicol, Wagner, Spurling and Stewart, Honigmann and others.

Peritonitis.—Parotiditis occurred as a complication with peritonitis in 10 cases, and in these cases, the mortality rate was 60 per cent. Three of these cases followed gynecologic operations.

Operation.—Parotiditis is seen a little more often in the combined surgical than in the combined medical services—1 in 1,621 to 1 in 1,779. It is most often found after major abdominal operations—1 in 650 cases.

Abdominal Operations.—Twenty-three of our 32 cases occurred in the surgical services, and of these, 8 followed gynecologic operations. Our incidence was 1 in 650 ordinary abdominal operations and 1 in 400 gynecologic abdominal operations. Two cases followed 1,020 operations on the biliary tract (1 in 500); 3 occurred after 300 operations on the stomach (1 in 100); 3 followed 2,640 cases of acute appendicitis (1 in 880), and 2 in 196 operations on the colon (1 in 100). Although we had no cases of infectious parotitis (mumps) complicating any abdominal operations. Addenbrooke and Elder reported cases of this sort. The higher incidence following operations on the colon is in agreement with the findings of Rankin and Palmer.

Carcinoma.—Seven of the cases occurred in patients with carcinoma (cases 14, 35, 36, 37, 45, 47 and 54)—2, of the cervix uteri (cases 36 and 37); 2, of the rectosigmoid (cases 45 and 54); 1, of the stomach (case 47); 1, of the urinary bladder with lung metastases (case 14), and

1, of the soft palate (case 35). Only in the last case could the disease have any direct influence on the occurrence of parotiditis. The total number of patients with carcinoma (not including those with sarcoma and other tumors) admitted during the period studied was 3,028, i. e., 3.1 per cent of the total number of admissions. Thus, in cases of cancer, parotiditis occurred once in 432 cases and once in 1,621 of all surgical cases.

The role of anesthesia in the causation of the disease has afforded a topic for speculation. Some, e. g. Wagner and Deaver, blame the anesthetist for traumatizing the gland in his attempts to push the jaw forward. But it has occurred in patients to whom an anesthetic had never been given. We have run across the statement that it has never been recorded after spinal anesthesia.

Twenty-one of our patients were given some kind of anesthetic for some operation preceding the parotiditis, as follows: 12, spinal only, procaine hydrochloride; 2, spinal and ether; 1, spinal and ethylene; 2, spinal and nitrous oxide and ether; 1, avertin with amylene hydrate; 1, morphine-scopolamine-cactin; 1, ether; 1, ethylene and nitrous oxide.

According to these records, then, spinal anesthesia can also claim a following of parotiditis cases, but one can say that the anesthetic was not a causative factor.

CLINICAL MANIFESTATIONS

The onset of parotiditis is more often sudden with rapid progression (in 38 of 56 cases) rather than gradual. The first complaint of the patient may be dryness of the mouth or sore throat with pain or soreness at the angle of the jaw (cases 26, 33, 54 and 55). The symptoms may sometimes be so mild before swelling occurs that the patient does not mention them unless questioned; in fact, often the patient is beyond sense of pain before ever the process begins. In a few cases, pain in the parotid region on opening the mouth or on chewing or swallowing or pain in the ear was present before any swelling was visible (cases 20, 38, 39 and 40). Early pain in the ear is possibly due to swelling of the glenoid lobe of the parotid which comes into close relation with the auriculotemporal branch of the third division of the fifth cranial nerve which supplies the parotid and the auricular branches of which supply sensation to the canal, the drum membrane, the tragus and the pinna and to the ear below the meatus externus, so that the inflamed parotid gland gives rise to pain referred along the branches of the nerve to the walls of the external auditory meatus and the tympanic membrane. These branches passing between the cartilaginous and bony parts of the wall of the external auditory canal may be directly compressed when the glenoid lobe of the parotid is inflamed. When the medial portion of the gland lying close to the pharynx is involved, pain and fulness in

the throat or difficulty in swallowing may be present (cases 17, 27, 32, 43 and 56).

Soon after any of these symptoms occur, there is usually a rise in the body temperature, and a swelling is noted just anterior or inferior to the ear at the angle of the jaw.

If the swelling is slight or gradual, there is mild pain, discomfort and soreness in the parotid area (cases 1, 8 and 41), but if the infection is severe and reaction to the inflammation is rapid, within a few hours a marked brawny edematous swelling occurs, frequently carrying the lower part of the ear out from the side of the head. Pain may be intense, and within twenty-four hours, the orbit, the cheek and the neck may be involved, and the overlying skin may or may not be red (cases 3, 6, 7, 9, 17 and 19). As the edema and the swelling increase, the patient may not be able to open the mouth. This was noted particularly in cases 42 and 49. The pain becomes intense, and symptoms of toxemia appear (cases 32, 42 and 49). At first the swelling is limited strictly to the area under which the gland lies. It ends abruptly at the zygoma. In front, its margin can be seen to descend more or less vertically near to the anterior margin of the masseter muscle and the part of the gland below the ear and the angle of the jaw stands out, carrying the lobule of the ear outward and forward and a little upward.

Varying with the intensity and the spread of the inflammation, the fever ranges from 100 to 104 F., and the white blood cell count ranges from 14,000 to 43,000 in 90 per cent of the cases, and only a few fail to show leukocytosis above 9,000. One patient with Still's disease and chronic leukopenia (case 21) showed a count of only 6,700. In 2 cases of mild parotiditis in children the count ranged from 7,000 to 8,500. The patients in cases 3 and 13 had a white blood cell count of 7,500, but here again the course of the parotiditis was only moderately severe.

Parotiditis was present bilaterally in 18 cases—32.1 per cent of all; it was right sided in 20 cases, and left sided in 18 cases. It is not unusual for both glands to enlarge within a few hours of each other (cases 1, 3, 6, 35, 41 and 50). In 1 patient (case 35), the enlargement began simultaneously in both glands, but one gland subsided only to become enlarged and acutely inflamed sixteen days later. In cases 5, 18 and 45, the second gland became involved four to fifteen days after the first.

When the gland on one side becomes swollen rapidly, it is possible that a slight swelling of the gland on the opposite side may be overlooked unless a thorough examination is made, as the swelling in one gland may be slight. The examining finger can palpate the edges of the gland almost as soon as swelling begins.

In 18 cases, the papillae of the parotid ducts were examined within seventy-two hours of the onset of parotiditis. The ducts were found to

be normal in 7 cases, and in the other 11, they showed a raised red edematous orifice with or without pus draining from the papilla. In 6 of the 11 cases, pus was draining from the duct within twenty-four hours of the onset.

Blood cultures were taken in 18 cases once or oftener and in some cases daily, but all cultures were negative except in case 55, in which culture showed Staph. aureus from the duct and the gland and Str. haemolyticus in the blood stream. This patient recovered.

If the inflammatory process is not interfered with, the swelling may subside without drainage (cases 1, 13, 15 and 41) or drain through the ducts (cases 8 and 48). In other cases, the pus may rupture into the ear or the pharynx or into the mouth (case 5) or form a superficial abscess and rupture through the skin, more often near the mastoid process (cases 5, 37, 47 and 53). When the glenoid lobe is abscessed, the pressure of the pus is directed against the weakest part of the external auditory canal near the bone, resulting in discharge of the pus into the canal (cases 2, 5, 21, 31 and 43). This can be avoided by early operation properly performed. The failure of such inflammation of the gland and the general reaction to subside in case 37 was due to a deep overlooked abscess which ruptured into the ear six days after the capsule of the gland had been opened, but nothing more had been done. Case 42 is another example. It is our belief that this could have been avoided by blunt probing of the gland with the unopened scissors. Petit was explicit in his directions of what to do to avoid this.

Extension into the neck is a frequent and serious complication of parotiditis. In some cases the extension is limited to the spread of the inflammatory edema, and in others there is extension of the acute purulent inflammation into the anterior and posterior triangles of the neck with burrowing of pus along the fascial planes (cases 2, 5, 6, 17, 27, 42 43 and 44). It is dangerous; 50 per cent of such patients died. This did not occur in a single case in which opening was done early and properly.

As the swelling of the gland progresses, the gland may became necrotic or gangrenous before there is an abscess formed (cases 16, 26, 39 and 40). This is due, perhaps, to internal pressure from edema and congestion and the unyielding tough fibrous capsule. The gland has been found black in twenty-four hours (case 39). Even when an abscess does form, fluctuation in some cases may not be palpable owing to the depth from the surface, the tension within the capsule or the swelling of the overlying tissue (case 34); this was attested by Petit and Gross. If an abscess forms in the portion of the gland lying beside the pharynx or in the glenoid lobe, it will not be palpable and may be found only when the gland is incised and probed or may be only inferred from the

subsequent course if pus ruptures into the ear or the pharynx. Such an abscess gives a peculiar quality to the voice not unlike that of peritonsillar abscess.

Necrosis is followed by sloughing, and even the facial nerve may be destroyed with permanent paralysis of the facial muscles on that side (cases 26 and 31). A temporary facial weakness may develop when the swelling is great (cases 27, 42 and 47) and disappear when the edema and the inflammation subside (cases 27 and 47). In 1 case, sloughing of the gland was followed by moderate secondary hemorrhage into the retromandibular space (case 42).

Psychosis may develop (Everke); we have had 2 patients in whom it did (cases 16 and 51). It may be due to fever and toxemia, but it is seen when there is meningeal irritation. In either case, it disappears when drainage is established. In both of our cases, it came on while the patients were convalescing and continued while the patients were in the hospital.

In 1 fatal case (case 31), in which acute mastoiditis and cavernous and lateral sinus thrombosis and general sepsis developed, there was a rupture of the parotid abscess into the external auditory canal with extension of pus back through an old perforation of the tympanic membrane to the middle ear and so to the mastoid. The patient presented symptoms of cerebritis, and an abscess was feared. The autopsy revealed none. Note that at the first and most important operation "a small incision was made." The danger of this variety was stressed by Albert.

During the course of severe parotiditis, acute inflammation of the submaxillary gland on one or both sides developed in 4 patients (cases 4, 16, 40 and 48). Two of these patients required drainage (cases 4 and 48). At one point, the submaxillary gland is separated from the parotid gland only by the fascial capsule, and it has been said that submaxillary gland inflammation may occur by direct extension. We do not find that this has ever been verified.

The patient in case 19 entered with severe pharyngitis. Cultures of the throat showed hemolytic streptococci. When parotiditis developed, the gland was incised, and forty-eight hours later, acute cellulitis and erysipeloid rash appeared. In the following days, the inflammation and the rash extended to the axilla and down the back, but the patient subsequently recovered. Cultures from the gland and the duct showed streptococci.

In 11 cases (cases 6, 16, 19, 26, 30, 38, 39, 40, 45, 46 and 51), the gland was incised within twenty-four hours, and in only 3 (cases 6, 19 and 26) was there any sign of pus, although the glands were unusually acutely inflamed.

To find staphylococcus present in pure culture in the gland of a patient known to have had streptococcic septicemia (case 55) does not

help to sustain the theory that the disease is blood borne. To find it present in the gland alone or to find the gland sterile while at the same time cultures from the duct are positive, pure or mixed, certainly does not help to convince one that all cases arise as ascending infections.

The following case, from the practice of one of us (W. T. C.) may or may not be an example of blood-borne infection:

Dr. ——, 29 years old, was bitten on the finger by an unruly patient. The wound suppurated, and after six weeks, the finger was amputated. The pus from the finger showed gram-positive fusiform bacilli and staphylococcus, and the discharge was foul smelling. One week after the amputation, the patient was suddenly stricken with what looked like an attack of acute cholecystitis. This was so severe that he was operated on within twenty-four hours. There was gangrene of the fundus of the gallbladder, and the fundus was tightly distended with brownish seropurulent material which smelled like the discharge from the finger. Exactly the same organisms grew from cultures of this as from those of the finger. Some days later, parotiditis suddenly developed; this was incised, and brownish seropurulent material with the same foul odor as that of the other discharges escaped. This also showed the fusiform bacilli and the cocci. Cellulitis of the neck developed, and subcutaneous metastatic abscesses were later widespread. From the first of the abscesses opened, the same organisms were recovered. The patient finally recovered and at the time of writing is still well.

Carr suggested that the disease might originate in the same way as the similar condition affecting the abdominal parotid, i. e., the pancreas. But are all agreed as to the origin of that?

TREATMENT

Treatment must be directed against the cause if the morbidity rate is to be appreciably reduced. Since the chief contributing factors of parotiditis seem to be poor oral and dental hygiene, dryness of the mouth from oral starvation, dehydration and decreased salivary secretion and general lowered resistance either from age with advanced vascular damage, nephritis, diabetes and respiratory infection or from acute inflammatory lesions with toxemia, such as peritonitis, prophylactic measures to prevent or to ameliorate these should help to reduce the incidence and to lessen the severity of the disease.

Fenwick, Charlton and others suggested care of the mouth and teeth preoperatively and the use of oral fluids, lemon and lemon candy stick. Dorrance advised gum chewing and like methods to maintain adequate parotid secretion. Many have used these methods, and we use them routinely. Morphine has been considered as inhibiting the secretions of the gland, and the use of atropine with it before operation has some effect in keeping the mouth temporarily dry, but there is no evidence to show that these have any relation to the occurrence of parotiditis.

Rolleston and Oliver thoroughly demonstrated that water by mouth during treatment for peptic ulcer reduces the incidence of parotiditis.

Prophylactic measures such as those hereinafter described should be instituted:

1. Dental caries, pyorrhea and pharyngitis should be corrected as soon as possible after entry. If the patient has any operative condition, unless operation is urgent, carrying out the procedure should be deferred until oral and dental hygiene are satisfactory and the upper respiratory area is free from infection.

2. Adequate fluid intake by mouth should be maintained when possible, and when not, at least cracked ice should be allowed, and the mouth and the throat should be flushed with sour-tasting fluids at least once every two hours.

3. The general resistance and the vitality of the patient should be improved by the intravenous administration of blood, serums, water, salt and dextrose.

4. The salivary flow should be encouraged by the use of chewing gum, lemon or orange juice and candy.

5. Proper nursing care is particularly important for those patients who are seriously ill and unable to care for their mouths, throats and teeth and who must be helped with their food, fluids and gargles. In elderly persons there is the tendency to sleep with the mouth open, and other people are mouth breathers. These particularly need care for oral dryness and foul mouth. Keep the mouth closed by a chin strap bandage, unless there is nasal obstruction. Frequent gargles with solution of sodium perborate (3 to 5 per cent in water) or other cleansing oral washes should be used.

If parotiditis supervenes in spite of all prophylactic measures, we continue to give attention to the condition of the mouth, but, in addition, the local condition is treated.

During the first twenty-four hours, local application of cold is used in all cases during the first day at least. It has been the custom of one of us (W. T. C.) to apply cold constantly during the first twenty-four hours and if the condition has improved or is no worse, to continue it. If the condition does not improve, hot packs or poultices of linseed meal made with 25 per cent glycerin in water are applied and changed frequently for another twenty-four hours. If improvement is now present, one may wait, but if not, the gland is uncovered right away, and then the hot applications are continued. We do not mean merely to give the patient a hot water bag or an electric pad and tell him to apply it. Better results are obtained with generous hot wet packs or poultices renewed once an hour at least. In 1939, one of us (E. R. G.) treated a patient outside the University's hospitals, using 120 grains (7.76 Gm.) of sulfanilamide for the first twenty-four hours and 80 grains (5.18 Gm.) for each of the following days. Although the onset

was abrupt and the gland swelling extensive, in the first twenty-four hours, the inflammation did not progress, and the patient recovered without surgical intervention. Since 1939, sulfathiazole (2-[paraaminobenzenesulfonamido]-thiazole), which is considered most effective against staphylococcus, has come into use, but no patient whose case is here reported received it. Since the offending organism is usually staphylococcus, sulfanilamide derivatives may completely alter the treatment, the prognosis and the mortality rate of parotiditis. At present, surely, early and adequately large doses of sulfathiazole are indicated.

Many have advised waiting until pus forms, determinable by fluctuation or aspiration, and then opening. Some have advised massage and aspiration of the duct. Others give iodine and potassium iodide (e. g., Morison). More recently roentgen and radium radiation have had their advocates. In our series, roentgen radiation was used on only 2 cases (cases 48 and 50), and radium was not used at all. Bowing and Fricke presented figures to show that treatment with radium gives a better prognosis—a 23 per cent mortality rate.

Our study seems to indicate that early operation gives better results than late operation or expectant treatment. We had 24 patients operated on under seventy-two hours with a mortality rate of 29.1 per cent. There were 17 operated on after seventy-two hours with a mortality rate of 41 per cent. There were 15 on whom no operation was performed; 8 of these died—a mortality rate of 53.3 per cent. Early operation is probably avoided because of the physician's belief that no operation should be done before suppuration is demonstrable.

We made cultures from 16 patients operated on within forty-eight hours (there was no fluctuation in any of these). The cultures failed to yield a growth in only 3 cases, and in 1 of the 3 (case 40) the gland was gangrenous. Gangrene was present in cases 16, 39, 40 and 55 within twenty-four hours. Among 24 patients operated on within seventy-two hours pus was present in 8 only—33.3 per cent. And among these, although pus was said to be present, in not one had fluctuation or abscess developed. "The pus infiltrates into the tissue," wrote Cruveilhier and others. We feel, therefore, that to delay uncovering the gland is to increase the hazard. To do less than uncover the gland in the early hours, we feel cannot do much good. Simple incision before abscess has formed will probably be ineffective. After it has been uncovered, the hot moist (hypertonic) application should be continued.

The fear of scarring is another factor which is likely to defer operation. Properly placed incisions leave a scarcely noticeable scar.

We have run across the following dictum in the works of Paget and of some others: "Parotidites omnes, ante maturitatem semper aperiendae." We have not found who first said it, but a thesis by Baron, in 1744, disputed the axiom. (The same thesis, word for word,

was accepted from another candidate twenty-four years later.) So it seems to have had the weight of authority. We think Baron was right, that opening should not be done in all cases before maturity but it seems to us that those which are plainly no better after forty-eight hours' treatment should at once be uncovered. Of course, when the disease occurs in a manifestly dying patient, any operation is contraindicated.

We have spoken of uncovering the gland. A vertical skin incision is made in front of the ear connecting with an oblique incision below and behind the ear. If the vertical incision is kept close to the ear and if one cuts only deep enough to incise the capsule, there is no danger of cutting either a large vessel or the facial nerve. With the blunt scissors, the capsule is separated from the gland forward to its anterior border, and then the capsule only is incised with a transverse incision just below the zygoma and another just above the angle of the jaw. The unopened scissors is then thrust into the gland in various places and opened as withdrawn. The oblique incision below follows the natural crease or groove in the skin and reaches well forward, incising the gland capsule and uncovering the gland from its most posterior tip behind the ear to its most anterior tip below the angle of the jaw. The edges of the incised capsule are now reflected (both the upper and the lower surfaces) until the whole gland has been exposed to view. A bit of rubber is placed between gland and capsule everywhere, and the wound is left wide open and hot hypertonic packs with 25 per cent glycerin are applied and renewed pro re nata.

PROGNOSIS

In many cases the prognosis must be that of the accompanying disease. Patients who are moribund before parotiditis begins will probably die sooner on account of it. Others, not fatally ill, may soon become so because of it.

So long as the infection remains confined to the gland, the danger is not great, but once the capsule is broken and the infection invades the neck, the prognosis becomes bad—50 per cent of the patients with this type died. Or if the base of the skull becomes bathed in pus, meningitis with death is likely to ensue; this was the observation of Orthner and was exemplified in our case 31.

In the 56 cases here recorded, 37 patients recovered, and 19 died. The patient in case 48 is considered as recovered since he had fully recovered from parotiditis before the last operation was undertaken. Thus, there were 19 deaths in 56 cases—a general mortality rate of 33.9 per cent. The mortality rate is highest of all among those who have the cardiovascular-renal changes incident to or causing hypertension or occurring as a consequence of old age or constitutional disease. These constituted one fifth of our patients, and their mortality rate was

81.8 per cent. Peritonitis from almost any cause has a poor prognosis. Among the cases of parotiditis occurring in the course of this disease there was a death rate of 60 per cent. There were 23 cases which followed abdominal operations, and 9 of the patients died (6 with associated general peritonitis)—a mortality rate of 38.1 per cent (the general mortality rate, 33.9 per cent). Altogether there were 32 cases which followed operative conditions, and 10 of the patients died—a mortality rate of 31.2 per cent.

It has been said that gangrene of the gland always results in death. This in our series was not true. There were 10 patients with gangrenous

TABLE 4.—*Mortality Rates in Published Reports*

Author	Mortality Rate, per Cent	Cases Reported
Morely	25.2	57
Charlton	30.7	13
Bowing and Fricke	22.8	184
Spurling and Stewart	36	22
Blair and Padgett	42.5	35

TABLE 5.—*Mortality Rate in Relation to Decade of Life*

Decade	Cases	Deaths
First	1	0
Second	2	1
Third	15	3
Fourth	6	2
Fifth	11	2
Sixth	9	3
Seventh	5	1
Eighth	4	4
Ninth	3	3

glands (cases 5, 16, 26, 27, 39, 40, 47, 50, 52 and 55) and of these only 3 died (cases 39, 40 and 52)—a mortality rate of 33.3 per cent (general mortality rate, 33.9 per cent).

Again, we have read that "bilateral cases are likely to end fatally." In this series there were 18 cases of bilateral parotiditis (cases 1, 3, 4, 5, 6, 9, 16, 18, 25, 35, 37, 41, 43, 45, 46, 48, 50 and 56), 32.1 per cent of all. Thirteen of the patients recovered—a mortality rate of 27.7 per cent (general mortality rate, 33.9 per cent).

There were 38 cases of unilateral parotiditis, and 14 of the patients died—a mortality rate of 36.8 per cent (general mortality rate, 33.9 per cent).

Table 4 shows the mortality rate in some published papers in which more than 10 cases were reported.

Table 5 shows the mortality rate in relation to age by decades.

CONCLUSIONS

Any acute parotiditis other than mumps is a surgical disease from beginning to end. This is true whether the disease occurs per se or as a complication or sequel of some other disease.

The incidence in ordinary hospitals in the St. Louis area is about 1 in 2,000 cases.

The disease occurs with almost equal frequency among the medical and surgical patients, but of the cases occurring in surgical patients, about 85 per cent follow major surgical operations.

Parotiditis occurs most often in those with dry and at the same time poorly cleansed mouths (tongues and teeth).

The most frequent bacterial cause is staphylococcus (aureus and albus).

Early treatment with adequately large doses of sulfanilamide derivatives is indicated. At present, sulfathiazole is probably best.

The mortality rate is lower among those cases in which there are surgical indications if incision and uncovering of the gland are done early and properly.

Simple incision is of use only when frank abscess exists.

While our experience with treatment by radiation is too small to be of value, nevertheless, the published reports of those who have had large experience with this treatment, particularly with radium, seem to indicate that it is a valuable form of treatment.

The safest form of operative treatment consists in uncovering the whole gland and making multiple openings in its substance with a blunt instrument.

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DUODENAL BULB ACIDITY UNDER FASTING CONDITIONS IN PATIENTS WITH DUODENAL ULCER

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From the standpoint of the frequency of clinical occurrence, the most susceptible of the areas subject to the ulcerating influences of the acid gastric juice is the first part of the duodenum. Yet, there is little information available regarding the acidity in this important ulcer-bearing region in marked contrast with the extensive studies made on acidity in the stomach.

The study to be reported was undertaken to obtain data on acidity in the duodenal bulb under fasting conditions in patients with an ulcer at that site for comparison with comparable data obtained during digestion in the same subjects [1] and with data from fasting normal subjects.[2] The results will widen the knowledge of the trend of events in the duodenal bulb and should enable further appraisal of the relation between the acidity in this area and that simultaneously observed in the stomach. The comparisons, we hope, will shed more light on the effect of ulceration on the reaction and the neutralizing ability of the contents of the duodenal bulb and will afford better criteria with which to evaluate the acid factor in duodenal ulcer.

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From the Departments of Medicine and Physiology of the Jefferson Medical College of Philadelphia.

This paper is a portion of a thesis submitted by Dr. Berk to the Faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfilment of the requirements for the degree of Doctor of Science in Medicine for graduate work in internal medicine.

1. Berk, J. E.; Rehfuss, M. E., and Thomas, J. E.: The Effect of Ulcer on the Acidity and Neutralizing Ability of the Duodenal Bulb, Arch. Int. Med., to be published.

2. Berk, J. E.; Rehfuss, M. E., and Thomas, J. E.: Duodenal Bulb ("Ulcer-Bearing Area") Acidity in Fasting Normal People, J. Lab. & Clin. Med., to be published.

MATERIAL

The 26 subjects utilized for the purpose of this study were selected at random from the wards and the outpatient gastrointestinal clinic of the Jefferson Medical College Hospital. All presented symptoms suggestive of an active ulcer; some had a history of episodes of bleeding, and all showed an active nonobstructive duodenal ulcer without any recognizable lesion in the stomach when examined roentgenologically. A few were examined additionally with a gastroscope and showed a normal gastric mucosa.

Experiments were considered technically satisfactory in 23 of the subjects (17 males and 6 females), and only the results from these were accepted. The age of the entire group ranged from 21 to 59 years with an average of 41.7 years. The male subjects ranged in age from 21 to 57 years with an average of 40.7 years; the female subjects, from 21 to 59 years of age with an average of 44.2 years.

METHOD

Each subject was studied in the morning before breakfast and after a fast of at least twelve hours. A specially constructed tube with a double lumen was employed, and a method was followed which furnished more or less fluoroscopic control as well as roentgen proof of the position of the tube.[3] All the patients had experienced varying numbers of previous gastric analyses, and the swallowing of a tube was for them an easy and accustomed procedure. For the same reason, they were able to take a meal with the tube in place without undue difficulty and without nausea or vomiting. We were able, in a number of patients, to manipulate the tube from the stomach into the duodenum with the aid of fluoroscopic guidance. The remaining patients were placed at rest on their right sides and instructed slowly to swallow the tube over a period of half an hour; during this time they were left alone in a quiet darkened room. In some instances the tube had to be withdrawn at the end of this time and reswallowed. The experiment was discontinued or discarded in all cases in which there was occasioned any distress, nausea or vomiting.

After the desired position of the tube was satisfactorily achieved and fluoroscopically confirmed, specimens were withdrawn simultaneously from the pars pylorica and the duodenal bulb at ten minute intervals for half an hour. The p_H of each sample was determined without delay through the use of a Leeds-Northrup p_H indicator, which employs a glass electrode. The free and the total acidity of each specimen were titrimetrically estimated after filtration, Töpfer's reagent and phenolphthalein being used as the respective color indicators. On each duodenal sample, in addition, there was determined what we called the "excess neutralizing ability." This consisted of the amount of tenth-normal hydrochloric acid needed to bring about a positive colorimetric reaction for free acid.[4]

Of the 74 experiments which were made, 63 were accepted as satisfactory from the technical viewpoint. These comprised 1,369 separate determinations, consisting of 381 estimations of p_H, 398 determinations of free acid, 398 determinations of total acidity and 192 estimations of excess neutralizing ability of the duodenal contents.

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RESULTS

Acidity in p_H Units (fig. 1).—Stomach: The average gastric p_H for the entire observation period was 1.62, indicating a much greater acid concentration than did the corresponding average p_H in fasting normal subjects (p_H, 3.51).[2] This was seen further in the fact that all the samples in these fasting patients with ulcer had a p_H below the critical level of 3.5 which we had adopted as indicating the presence of free acid,[4]

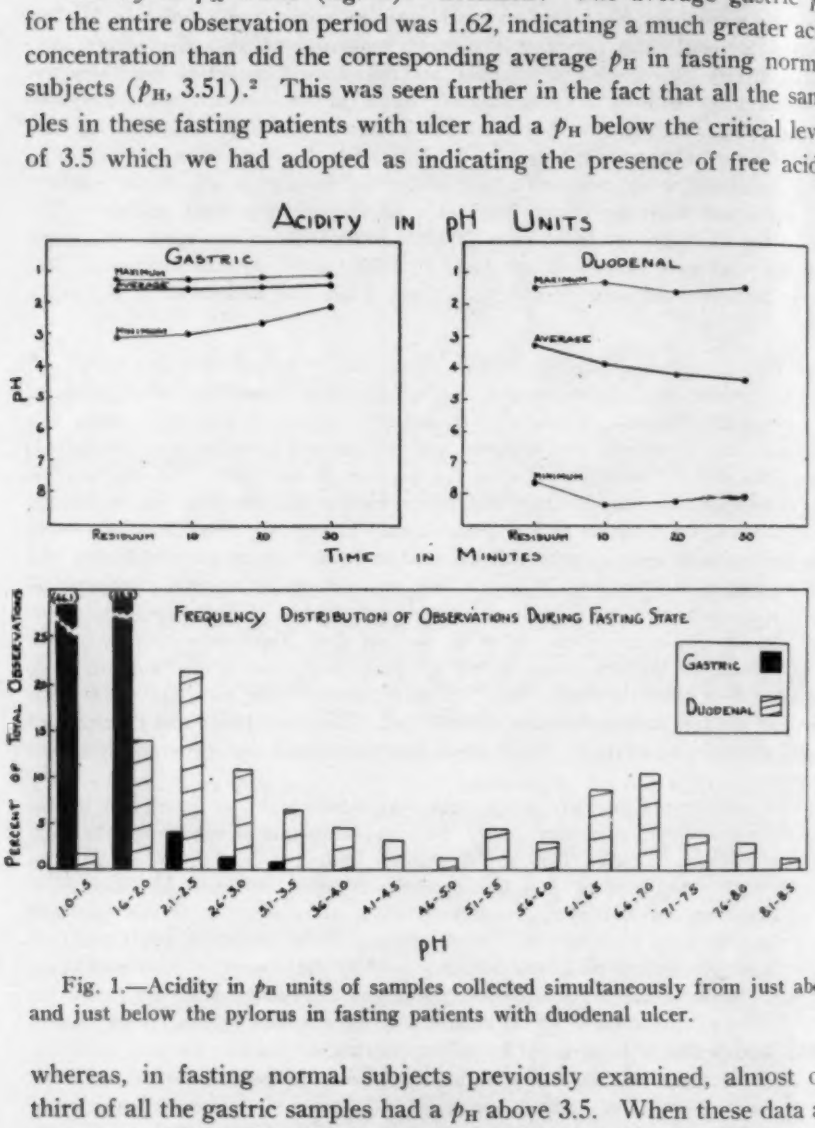

Fig. 1.—Acidity in p_H units of samples collected simultaneously from just above and just below the pylorus in fasting patients with duodenal ulcer.

whereas, in fasting normal subjects previously examined, almost one third of all the gastric samples had a p_H above 3.5. When these data are compared with similar data from patients with ulcer fed an Ewald meal,[3] the average p_H values are seen to be approximately equal, and the range of the individual values practically coincide.

Duodenum: The over-all average duodenal acidity in terms of p_H was 3.96, which was much greater than that previously found in fasting normal persons (5.60). Furthermore, over half (55.8 per cent) of all

the samples from fasting patients with ulcer had a p_H above 3.5 (positive for free acid) compared with only one fourth (26 per cent) in fasting normal subjects. Despite the increase in over-all acidity, there was a consistent difference in p_H between specimens simultaneously withdrawn from areas just above and just below the pylorus, which averaged 2.34 p_H units. This difference exceeded that in fasting normal subjects (2.09 p_H units). Of all the average duodenal p_H values, only that for the first sample (fasting duodenal residuum) was less than the critical value for free acid.

The line representing the plotted values for average duodenal p_H showed a trend toward decreasing acid concentrations with each aspiration. This line, just as in normal subjects, was of an entirely different configuration than the corresponding one for average gastric p_H.

Fluctuation in the reaction of the contents of the first part of the duodenum was more pronounced in these patients than in normal subjects, although the contrast between the two groups in this respect was not so prominent under fasting conditions as during digestion.[1]

Free Acid (fig. 2).—Stomach: Gastric free acid averaged 31 clinical units. This and also the range of distribution of the individual values exceeded those in fasting normal people (average 15 clinical units). In both respects the findings closely resembled those in patients with ulcer after an Ewald meal.

It is interesting to note the difference in pattern of the graphic curves of average gastric free acid and average duodenal p_H (fig. 1).

Duodenum: Free acid as determined colorimetrically was present in the contents of the first part of the duodenum in 44.4 per cent of the samples. This is more than four times the frequency observed in fasting normal persons. The percentages are less than the corresponding figures based on p_H values (fig. 1) owing to a certain number of false negative readings resultant from our method of filtration and dilution of the samples preparatory to colorimetric titration.[4] Since our end point with Töpfer's reagent was about p_H 3.5, we assumed that all samples of which the p_H in the unfiltered, undiluted state was 3.5 or less contained free acid.

Colorimetrically, 60.8 per cent, and electrometrically, 78.2 per cent, of all the patients with ulcer used in this study had free acid in the contents of the duodenal bulb as compared with 22.7 per cent, colorimetrically, and 40.9 per cent, electrometrically, of fasting normal subjects previously studied. Free acid, when present, tended to persist over a longer period than in normal subjects. For example, of the fasting patients with ulcer, 8.7 per cent, colorimetrically, and 39.1 per

cent, electrometrically, showed free acid in every one of the four observations, whereas colorimetrically, none, and electrometrically, only 1 normal subject showed this.

Despite a fairly close similarity in average values and in range of values for gastric free acid, fewer fasting patients with ulcer showed free acid in the contents of the duodenal bulb than did the same patients after an Ewald meal, and fewer duodenal samples were positive for free acid under fasting conditions than during the digestive phase.

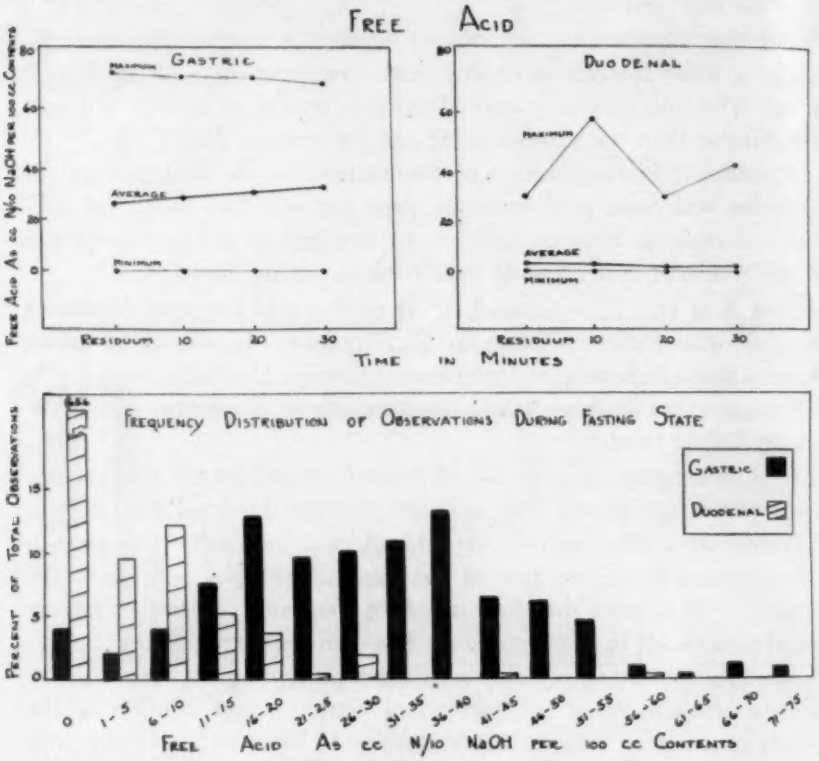

Fig. 2.—Free acid as determined on samples collected simultaneously from just above and just below the pylorus in fasting patients with duodenal ulcer.

Total Acidity (fig. 3).—Stomach: Total acidity in the stomach averaged 58 clinical units, which exceeded the corresponding value found in fasting normal subjects (38 clinical units). However, both the average value and the range of the individual values were less than those observed after a meal in the patients with ulcer.

The line representing the plotted values for average gastric total acidity showed rather prominently the trend toward increased acidity

values with each successive determination; this was seen also in the case of average gastric p_H and free acid. There was a divergence between this line and those representing average duodenal p_H (fig. 1) and average duodenal total acidity (fig. 3), respectively.

Duodenum: The average total acidity in the duodenal samples was 24 clinical units; this also was greater than that found in fasting normal subjects (18 clinical units). However, these values indicated a reduction

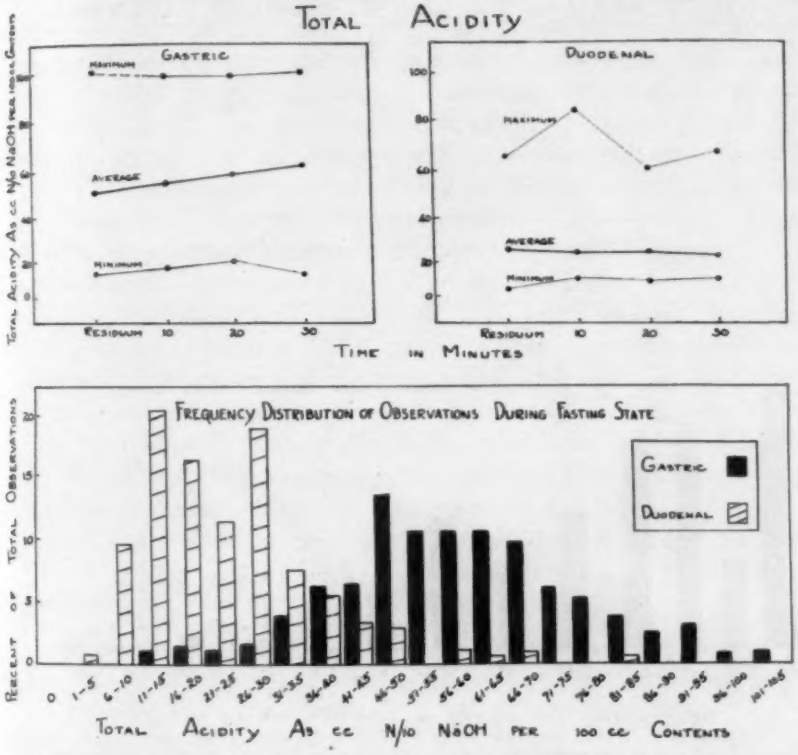

Fig. 3.—Total acidity of samples collected simultaneously from just above and just below the pylorus in fasting patients with duodenal ulcer.

from the average gastric total acidity of 59 per cent in the patients with ulcer as compared with 53 per cent in normal subjects.

Excess Neutralizing Ability of the Duodenal Contents (fig. 4).—"Excess neutralizing ability of the duodenal contents" has been defined as a measure of reserve capacity which the contents of the duodenal bulb possess to neutralize, buffer and dilute the gastric secretions above that necessary to offset free acid content.[4]

The average excess neutralizing ability of the duodenal bulb contents was 11 clinical units, which is less than that found in either fasting

normal persons (17 clinical units) or patients with ulcer after an Ewald meal (14 clinical units). Of all the duodenal samples, 37.5 per cent failed to show any excess neutralizing ability as compared with 14.5 per cent of those from fasting normal subjects and 43.1 per cent of those from patients with ulcer fed an Ewald meal. The range of the individual values was slightly less than in fasting normal subjects and distinctly less than in patients with ulcer after an Ewald meal.

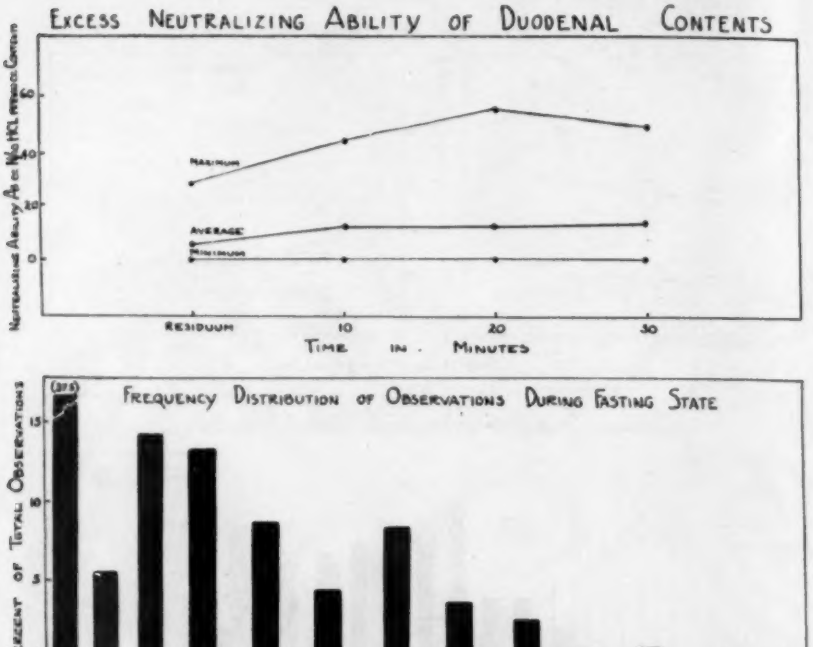

Fig. 4.—Excess neutralizing ability of the contents of the first part of the duodenum in fasting patients with duodenal ulcer.

COMMENT

Whether or not the stomach has a true fasting secretion is still controverted.[5] Aside from the local and constitutional changes in

5. (*a*) Babkin, B. P., in Contributions to the Medical Sciences in Honor of Dr. Emanuel Libman by His Pupils, Friends and Colleagues: Does the Stomach Secrete Gastric Juice Continuously? New York, International Press, 1932, vol. 1, p. 113. (*b*) Bloomfield, A. L.; Chen, C. K., and French, L. R.: Basal Gastric Secretion as a Clinical Test of Gastric Function with Special Reference to Peptic

(Footnote continued on next page)

patients with ulcer, which are believed to induce a more or less continual excitation of gastric secretion, other stimuli, normal and abnormal, sufficient to affect the secretory activity of the stomach [5a] probably existed in our patients despite our efforts to minimize them and to produce a true state of stomach rest. Furthermore, a fair degree of experimental error exists in our method of study so that we could not be certain, in spite of all our precautions, that the material supposedly aspirated from the pars pylorica and the duodenal bulb was actually obtained from those regions in every instance. We make no claim, therefore, that the quantitative values we obtained necessarily represent the acidity values which are characteristic for these areas in all patients with duodenal ulcer under fasting conditions. We believe, however, that there are no serious objections which can be raised against their use for purposes of comparison with corresponding values obtained under similar experimental conditions in fasting normal subjects or in patients with ulcer fed an Ewald meal.

Our observations confirm the findings of other investigators [6] to the effect that fasting values of gastric acidity are higher in patients with duodenal ulcer than in normal people. It is probably highly significant that in terms of average values, gastric acidity in fasting patients with ulcer approximates those in the same patients following an Ewald meal; in individual instances, the values during fasting are even greater. We made no attempt to measure the volume of material obtained, but it was our impression that, in general, the patients with ulcer have larger amounts of fasting secretions, both gastric and duodenal.

The contents of the first part of the duodenum are not only more acid in fasting patients with duodenal ulcer than in fasting normal

Ulcer, J. Clin. Investigation **19**:863, 1940. (*c*) Carlson, A. J.: The Secretion of Gastric Juice in Health and Disease, Physiol. Rev. **3**:1, 1923. (*d*) Pavlov, I. P.: The Work of the Digestive Glands, Philadephia, J. B. Lippincott Company, 1910. (*e*) Polland, W. S., and Bloomfield, A. L.: Basal Gastric Secretion in Man, Bull. Johns Hopkins Hosp. **49**:302, 1931. (*f*) Rehfuss, M. E.; Bergeim, O., and Hawk, P. B.: Gastro-Intestinal Studies: I. The Question of the Residuum Found in the Empty Stomach, J. A. M. A. **63**:11 (July 4) 1914. (*g*) Rehfuss, M. E.: The Diagnosis and Treatment of Diseases of the Stomach, Philadelphia, W. B. Saunders Company, 1927.

6. Bloomfield, A. L.: The Problem of Gastric Hyperacidity, Am. J. Digest. Dis. **6**:700, 1939. Bockus, H. L.; Glassmire, C., and Bank, J.: Fractional Gastric Analysis in Two Hundred Cases of Duodenal Ulcer, Am. J. Surg. **12**:6, 1931. Vanzant, F. R.; Osterberg, A. E.; Alvarez, W. C., and Rivers, A. B.: Studies of Gastric Pepsin: II. Secretion of Pepsin in Cases of Duodenal Ulcer and Pseudo-Ulcer, J. Clin. Investigation **12**:557, 1933. Winkelstein, A.: One Hundred and Sixty-Nine Studies in Gastric Secretion During the Night, Am. J. Digest. Dis. & Nutrition **1**:778, 1935. Bloomfield, Chen and French.[5b] Rehfuss.[5g]

subjects, but duodenal neutralizing capacity is overcome for longer periods. The ability of the contents of the duodenal bulb in fasting patients with ulcer to neutralize, buffer and dilute the gastric secretions is still in evidence, even though inadequate to maintain constantly a normal reaction in the duodenum in the presence of the increased gastric acidity. It is, however, such that in fasting patients with ulcer the increase over the normal in duodenal acidity falls far short of proportionately paralleling that in the stomach; the average duodenal acidity in terms of p_H represents an increase over normal values of only 29.2 per cent, whereas the average gastric acidity is increased by 53.8 per cent over the normal.

The increased acidity in the duodenal cap of fasting patients with ulcer does not appear to be accounted for alone by the higher values for gastric acidity which they display. When the average acidity in terms of p_H in the stomach and the duodenum in our group of patients with ulcer was compared with acid values of a group of 6 normal subjects whose gastric acid values were comparable to those of patients with ulcer and who were studied in the same manner, it was found that despite similar average gastric p_H values in both groups (p_H 1.62 and 1.63, respectively), the average duodenal p_H in normal people was higher (patients with ulcer, 3.96; normal subjects, 4.24). The difference, it is true, was not great, yet a similar but somewhat wider deviation from the normal in this respect was noted by us in a group of patients with ulcer when compared after receiving an Ewald meal with normal subjects whose gastric acidity was likewise high.[1] While by no means conclusive, such findings strongly suggested that in patients with duodenal ulcer there is inadequate neutralization of the gastric acid in the duodenal bulb as well as gastric hypersecretion. The more pronounced fluctuation in the reaction of the contents of the first part of the duodenum of fasting patients with ulcer may represent another expression of a defective duodenal neutralizing mechanism. Some derangement in duodenal neutralization has been suggested before as one of the basic disturbances in duodenal ulcer,[7] and our results support this impression.

The neutralizing capacity of the contents of the duodenal cap in patients with ulcer under fasting conditions appears to be as good or better than during digestion of an Ewald meal. Under fasting conditions, in spite of a fairly close similarity in gastric acidity during

7. Kearney, R. W.; Comfort, M. W., and Osterberg, A. E.: Hydrogen Ion Concentration of the Duodenal Contents Under Fasting Conditions in Normal Persons and in Patients with Duodenal Ulcer: A Comparative Study, J. Clin. Investigation **20**:221, 1941. Morton, C. B.: (*a*) Observations on Peptic Ulcer: VI. Preliminary Report of Clinical Experiments with Gastro-Duodenal Analysis, Am. J. M. Sc. **177**:65, 1929; (*b*) Observations on Peptic Ulcer, South. Surgeon **3**:316, 1934.

fasting and after a meal, fewer patients have free acid in the contents of their duodenal bulbs; fewer duodenal samples contain free acid, and the average excess neutralizing ability of the duodenal bulb contents is less. These may be indications of a more efficient regulatory mechanism under fasting conditions. On the other hand, they may indicate merely that a greater strain is thrown on an inadequate mechanism during digestion.

Of great interest was the lack of sharp parallelism between the several indexes of gastric acidity on the one hand and the duodenal p_H as well as the other corresponding indexes of duodenal acidity on the other. On the strength of the discrepancies apparent in the several graphic curves, it seems well advised to warn that none of the customary measures of gastric acidity can be taken as reliable indexes of the behavior of the hydrogen ion concentration in the duodenal bulb over the same period.

SUMMARY AND CONCLUSIONS

Under fasting conditions, the contents of the first part of the duodenum in patients with duodenal ulcer are more acid than in normal subjects. In fasting patients with ulcer, they have an average p_H of about 3.9.

During fasting, free acid is found more often in the contents of the first part of the duodenum in patients with an ulcer in that situation than it is in normal subjects. Free acid when present in the duodenal bulb contents in fasting patients with ulcer tends to persist for longer periods than in normal persons.

The ability of the contents of the duodenal bulb in fasting patients with ulcer to neutralize, buffer and dilute the gastric secretions is impaired but not wholly lost. The impairment is probably largely due to gastric hypersecretion, but a defective neutralizing capacity in the duodenal bulb seems to be present as well.

The neutralizing capacity of the contents of the duodenal cap in patients with ulcer under fasting conditions appears to be as good as or better than during digestion of an Ewald meal.

There is no constant parallelism in the behavior of the simultaneously determined gastric and duodenal bulb acidity.

Dr. B. B. Vincent Lyon permitted the use of the patients and facilities of the gastrointestinal clinic, and Drs. Melvin Dillman and Karl Kornblum performed the roentgen studies on each subject.

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CAPILLARY PERMEABILITY AND INFLAMMATION IN THE SKIN OF RABBITS

EXPERIMENTAL STUDIES FOLLOWING SECTIONING OF THE SPINAL CORD

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AND
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Lauer [1] recently stated that the intensity of the inflammatory reaction was diminished after sectioning the spinal cord. The reactions, however, were similar above and below the injured segment of the cord. The similarity of these two inflammatory reactions, therefore, would make it impossible to ascribe this diminished reaction either to the separation of the organ from its nervous centers or to the loss of pain sensations.

Capillary permeability and inflammation in the skin of the rabbit have been studied by one of us (R. H. R.[2]). The technic used in these studies consisted of applying xylene to the shaven skin of the rabbit at intervals preceding the intravenous injection of trypan blue. A definite pattern of localization of dye occurred in the xylene-treated areas. This dye localized first and in the largest quantity in the area where xylene was applied the shortest time before the dye was injected. The localization and the concentration of dye in the xylene-treated areas of skin occurred inversely with the interval between the application of the irritant and the injection of the dye. If the irritant was placed on a local area of skin thirty minutes before the dye was injected, a smaller amount of dye localized and concentrated in the area than occurred in an area where xylene was applied immediately before the dye was

From the Departments of Surgery and Pathology, the University of Tennessee College of Medicine.

This study was aided by grants from the John and Mary Markle Foundation and the University of Tennessee.

1. Lauer, N.: Influence of the Central Nervous System on Inflammatory Reactions: IV. Influence of Cord Section on Non-Specific Inflammation, J. Med. Ukraine **9**:29-38, 1939; abstracted, Brit. Chem. & Physiol. A. **3**:113, 1940.

2. Rigdon, R. H.: Capillary Permeability in Areas of Inflammation Produced by Xylene, Arch. Surg. **41**:101 (July) 1940.

injected. When the irritant was applied three hours or longer before the dye was injected, no more dye localized and concentrated in the xylene-treated areas of skin than in the untreated skin.

The problem of capillary permeability and inflammation has been studied also by intradermally injecting various irritants, such as aleuronat, staphylococci and staphylococcus toxin and thereafter removing the tissues at various intervals for microscopic study. Variations in the normal pattern of the localization of trypan blue and an inhibition in the localization of leukocytes induced by the application of xylene have been found; first, in animals narcotized by ether and alcohol [3]; second, in those given large doses of epinephrine [4]; third, in rabbits sick as a result of a severe staphylococcus septicemia,[5] and fourth, in animals suffering from a profound lowering of the blood pressure following hemorrhage.[6]

Since the tone of the blood vessels is affected to a definite degree by sympathetic impulses transmitted through the spinal cord and since the vascular reaction is of such importance in the mechanism of inflammation, it was decided to study this reaction in the skin of rabbits following the sectioning of the spinal cord.

MATERIALS AND METHODS

Adult rabbits were used. The skin over the abdomen and along the lateral portion of the thighs was carefully shaved twenty-four hours or longer before the experiments were begun. Xylene was carefully applied with a cotton applicator to local areas of the skin preceding the intravenous injection of 10 cc. of a 0.2 per cent solution of trypan blue. The time of the appearance of the dye and the intensity of the staining of the areas of skin were observed. In some of the experiments 0.2 cc. of a saline suspension of staphylococci and an equal quantity of a 1 per cent suspension of aleuronat were injected intradermally. The xylene-treated areas of skin and those into which aleuronat and staphylococci were injected were removed after varying intervals, and they were placed immediately into a 4 per cent solution of formaldehyde. Paraffin sections were prepared and stained with hematoxylin and eosin.

3. Cressman, R. D., and Rigdon, R. H.: Capillary Permeability and Inflammation in Narcotized Rabbits, Arch. Surg. **39**:586 (Oct.) 1939.

4. Rigdon, R. H.: A Study of Capillary Permeability and Inflammation in Skin of Rabbits Given Adrenalin, Surgery **8**:839 (Nov.) 1940.

5. Rigdon, R. H.: An Experimental Study of Capillary Permeability and Inflammation in Rabbits with Staphylococcus Septicemia, Arch. Surg. **44**:129 (Jan.) 1942.

6. Rigdon, R. H.; Miles, R. M., and Bland, R. P.: The Effect of Low Blood Pressure upon Capillary Permeability and Inflammation in the Skin of the Rabbit, Surgery, to be published.

The spinal cord was sectioned under local anesthesia induced with procaine hydrochloride. In some of the rabbits, the cord was cut at the seventh cervical segment and in others at the level of the fourth lumbar segment. A cannula was put into the carotid artery. The blood pressure was recorded at intervals with a mercury manometer.

The white blood cells were counted in some of these rabbits. Blood was removed from the ear. A standard technic was used for counting these cells.

EXPERIMENTAL

The cervical portion of the spinal cord was sectioned in 9 rabbits. The blood pressure was recorded in some of these both before and after the cord was cut. In some of the rabbits, the observations were made only following the sectioning of the cord. The normal pressure in these rabbits varied between 100 and 150 mm. of mercury. Immediately following the sectioning of the cord the pressure usually

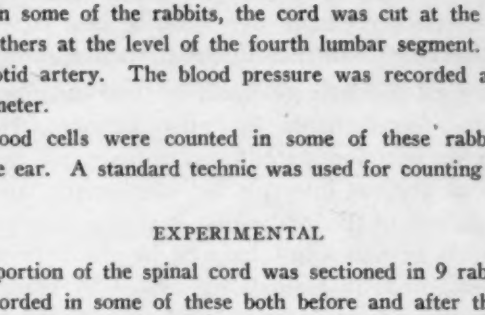

Fig. 1.—Xylene was carefully applied to areas of the skin of a normal rabbit at the time indicated before 10 cc. of trypan blue was injected intravenously. The largest amount of dye is present in the area where xylene was applied immediately before the dye was injected. There is no dye in the area where xylene was applied ninety minutes previously. The photograph was made ten minutes following the injection of the dye.

fell to approximately 50 mm. of mercury. During the following two or three hours, the pressure usually gradually increased, however, it again decreased, reaching a level of about 50 mm. of mercury or even lower within a period of five or six hours. There was essentially no variation in the level of the blood pressure over a period of six hours in 2 control rabbits.

Xylene was carefully applied to local areas of the skin of 10 rabbits in which the spinal cord was cut. The macroscopic reactions in the skin varied in the different rabbits. In some, the reaction developed the same as it did in the normal animals, while in others the reaction was either decreased or completely absent. This decrease in the inflammatory reaction occurred in the rabbits with a low

blood pressure. There appeared to be a definite correlation between the degree of reaction in the skin and the level of the blood pressure.

Trypan blue was injected intravenously into these rabbits. In the controls the dye localized and concentrated first in the area where xylene was applied for the shortest interval before the dye was injected (fig. 1). There was a gradual diminution in the quantity of dye that localized in the xylene-treated areas as the interval between the application of the irritant and the injection of the dye increased. Essentially the same amount of dye localized and concentrated in the areas of skin treated with xylene three hours before the dye was injected as localized in the untreated skin. The dye always localized in the xylene-treated areas of skin within a period of five minutes following the injection.

The following protocol of rabbit 693 shows the failure of trypan blue to localize and to concentrate in xylene-treated areas of skin in rabbits with the spinal cord cut and with an abnormally low blood pressure.

11:30 a. m. Cervical portion of cord cut.
11:31 a. m. Xylene applied to skin in area 1.
11:45 a. m. Area 1 was hyperemic.
1:45 p. m. The hyperemia in area 1 apparently was decreasing.
1:50 p. m. Blood pressure, 34 mm. of mercury.
3:00 p. m. Xylene applied to area 2.
3:15 p. m. Xylene applied to area 3; 10 cc. of trypan blue given intravenously; there was no hyperemia or edema in areas 2 and 3.
3:25 p. m. No trypan blue in any of the xylene-treated areas of skin.

In the rabbits with a slightly higher blood pressure than that shown, erythema and edema occurred; however, the condition was decreased from that in the normal rabbit. The pattern of the localization and concentration of trypan blue also was different in these rabbits from that of the normal as shown by the following protocol of rabbit 709:

10:30 a. m. Cervical portion of cord cut; xylene applied to area 1.
12:00 noon. Xylene applied to area 2.
1:00 p. m. Xylene applied to area 3.
1:30 p. m. Xylene applied to area 4.
1:45 p. m. Xylene applied to area 5.
2:00 p. m. Xylene applied to area 6; 10 cc. of trypan blue given intravenously.
2:05 p. m. Dye in areas 4 and 5 (fig. 2 *A*).
2:20 p. m. Dye in areas 4 and 5; less dye in area 6 than in area 5; less dye in area 3 than in area 4.
2:30 p. m. Dye in areas 3, 4, 5 and 6 (fig. 2 *B*).
4:00 p. m. Essentially the same amount of dye in areas 4, 5 and 6; there was less dye in area 3 than in area 4; no dye present in areas 1 and 2 (fig. 2 *C*).
4:15 p. m. Killed; sections removed for histologic study.

These experiments indicated that the development of the macroscopic changes in inflammation and the localization and the concentration of trypan blue in areas of inflammation are affected by the level of the blood pressure.

Sections of skin treated with xylene and areas injected with both aleuronat and staphylococci from 15 rabbits in which the cervical portion of the spinal cord was cut were studied. The interval between the injection of these irritants varied from two to six hours. There was a decrease in the leukocytic reaction in the rabbits with a low blood pressure as compared with the rabbits with a normal pressure. The rabbits with a low pressure failed to have any leukocytes around the irritants (fig. 3).

These experimental observations suggest that the sectioning of the spinal cord in the cervical region did not directly affect either the localization of trypan blue

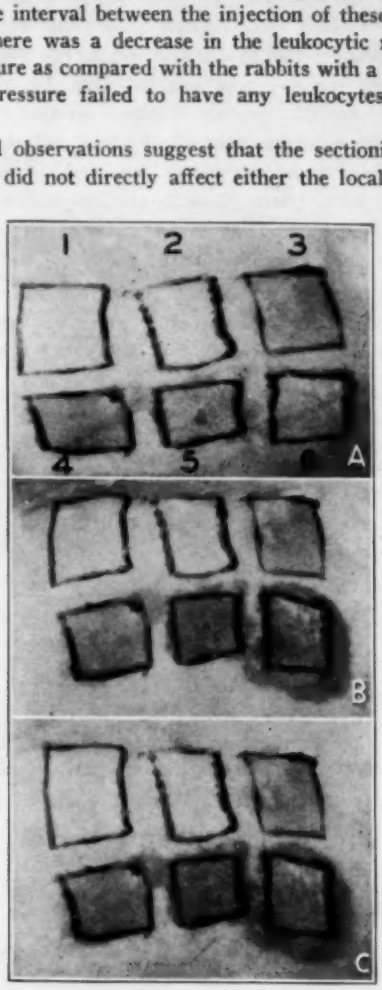

Fig. 2.—The cervical cord of this rabbit (709) was completely severed preceding the application of xylene to the areas of skin. Xylene was applied to area 1, three and a half hours before dye was injected; area 2, two hours; area 3, one hour; area 4, thirty minutes; area 5, fifteen minutes and area 6, immediately before. *A*, trypan blue is present only in areas 4 and 5 after five minutes. *B*, dye is present only in areas 3, 4, 5 and 6; photograph was made after thirty minutes. *C*, dye is present only in areas 3, 4, 5 and 6; areas 1 and 2 are hyperemic at this time. The photograph was taken two hours after the dye was injected.

or the localization of polymorphonuclears in areas of inflammation except secondarily as the result of the lowering of the blood pressure. The spinal cord was sectioned in the lumbar region of 7 rabbits in order to study the development of the

inflammatory reaction. Aleuronat and staphylococci were injected intradermally at intervals of six, four and two hours before the rabbits were killed. Clinically, the rabbits did not appear to be in shock. The blood pressure remained normal in those in which it was recorded. There was no difference in either the macroscopic or the microscopic reaction in these rabbits and that which occurred in the normal animals.

The leukocytes were counted in the blood from the ear of 3 rabbits both before and after the cervical portion of the spinal cord was cut. There occurred a diminution in the total white blood cell count immediately following the cutting of the cord; however, this variation was not outside the range of normal. It appears, therefore, that the failure of leukocytes to localize and to concentrate in

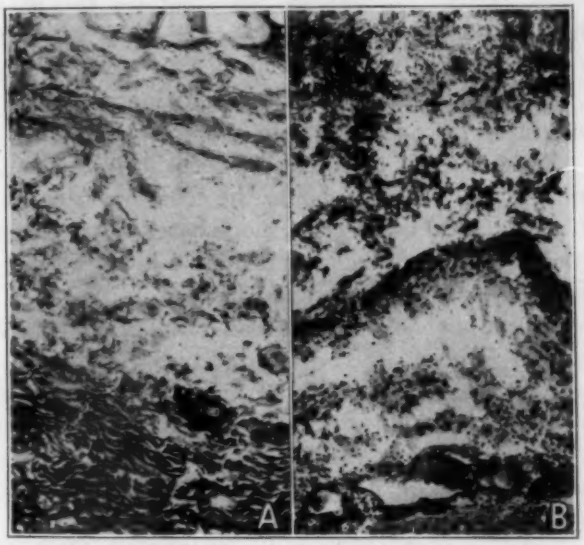

Fig. 3.—*A*, photomicrograph of a section removed from rabbit 387 four hours after the intradermal injection of 0.2 cc. of staphylococci. This rabbit's spinal cord was cut; the blood pressure was 50 mg. of mercury. The rabbit appeared to be in shock. Note the clumps of bacteria and the absence of leukocytes. *B*, photomicrograph of a section from rabbit 309, which served as a control for 387. There is a diffuse infiltration of the area with leukocytes.

areas of inflammation in these rabbits cannot be explained by an absence of white cells among the circulating cells.

COMMENT

Trypan blue localized and concentrated in the xylene-treated area of skin in the rabbits with the spinal cord severed at the level of the seventh cervical vertebra, if the blood pressure was normal, in a manner similar to that in normal rabbits. In contrast to this observation, the

dye failed to localize and to concentrate in the xylene-treated areas of skin in rabbits in which the cord was cut at the same level, and the blood pressure was markedly decreased. These observations suggest, therefore, that the variation in the localization and the concentration of trypan blue in the skin of rabbits following the cutting of the spinal cord is determined by the level of the blood pressure and is not influenced by the nerves.

Polymorphonuclear leukocytes failed to concentrate in the areas of skin injected with both aleuronat and staphylococci when the blood pressure was markedly decreased. The failure of leukocytes to concentrate in the areas of inflammation in the rabbit with the spinal cord cut in the cervical region and with an accompanying low blood pressure suggests that this same phenomenon may explain the failure of the leukocytes to concentrate in the skin of the rabbits given large amounts of epinephrine, sick following the intravenous injection of staphylococci and also with a low blood pressure following hemorrhage. It has been suggested that edema fails to develop and leukocytes fail to concentrate in the skin of rabbits in shock due to the constriction of the cutaneous vessels.[5] Unless clinical evidence of shock develops and the blood pressure is markedly decreased, the inflammatory reaction develops the same in animals with the spinal cord cut as in the controls.

Section of the lumbar cord may lower the blood pressure some; however, it rarely produces the profound picture of shock that frequently results from the cutting of the cord at the level of the seventh cervical vertebra. The degree of fall in the blood pressure following the cutting of the cervical cord is variable, as shown by the studies of Wilson, Roome and Grimson[7] on dogs. The present experiments show that similar variations occur in the rabbit.

The vasodilation in the skin that usually occurs either following the cutting of the spinal cord or the removal of the sympathetic ganglions in specific areas of the body apparently has little if any effect on either the localization of trypan blue or the concentration of polymorphonuclear leukocytes as demonstrated by this technic. It is suggested that the diminution in the inflammatory reaction as observed by Lauer[1] may be explained by a decrease in the blood pressure. This assumption is supported by his observation that the inflammatory reactions were similar above and below the severed segment. Furthermore, Lauer did not think that this diminished reaction could be ascribed to either the separation of the organ from its nervous centers or loss of pain sensations.

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7. Wilson, H.; Roome, N. W., and Grimson, K.: Complete Sympathectomy: Observations of Certain Vascular Reactions During and After Complete Exclusion of the Sympathetic Nervous System in Dogs, Ann. Surg. **103**:498 (April) 1936.

SUMMARY

The skin of the rabbit fails to show hyperemia and edema following the local application of xylene when the cervical portion of the spinal cord is cut, if the animal is also in shock.

Trypan blue fails to localize and to concentrate in the xylene-treated areas of skin of rabbits when they are in shock.

Polymorphonuclear leukocytes also do not concentrate in areas of skin injected with either staphylococci or aleuronat when the spinal cord is cut and the animals are in shock.

The sectioning of the spinal cord in the rabbit apparently has no direct effect on the development of the local inflammatory reaction provided the animals are not in shock as the result of the sectioning of the cord.

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PERINEPHRIC ABSCESS

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Suppuration in the perinephrium is of special importance because of the morbidity and mortality rates associated with the lesion. The disease is not uncommon. In the twenty-eight years since the first patient was admitted to the Peter Bent Brigham Hospital, 66 patients have been treated who were found to have perinephric abscess either alone or complicating other diseases. In addition, there were 6 other patients in whom the signs and the symptoms were most suggestive of perinephric abscess. They recovered without operation, however, and the diagnosis was consequently never proved.

The difficulties of diagnosis and the problems of treatment in patients ill because of perinephric abscess have been emphasized repeatedly in the literature.[1]

It was thought, therefore, that analysis of the cases to be described would yield data to help solve the many problems presented by infection in the perinephrium.

DEFINITION AND TERMINOLOGY

Perinephric abscess is a suppurative inflammatory lesion of the perinephrium, the fibrofatty bed surrounding the kidney in the lumbar gutter. The anatomy of this region was admirably described and illustrated by Gerota in 1895.[2] Confusion has existed in the past because of variation in the terminology used by writers. The term "paranephric abscess" should properly be reserved for lesions in the paranephric fat outside the fascia of Gerota. Such an isolated lesion is unusual, and recognition of it before operation is difficult. For clinical purposes, it is best to consider the surgical perinephrium as including anatomically both perinephrium and paranephrium. In thus simplifying the nomen-

From the Urologic Clinic of the Peter Bent Brigham Hospital and the Department of Surgery, Harvard Medical School.

1. (*a*) Miller, M. B.: Perinephric Abscess, Ann. Surg. **51**:382-415, 1910. (*b*) Mathé, C. P.: Diagnosis and Treatment of Perinephric Abscess: Renal Fixation, a New Roentgenographic Diagnostic Sign, Am. J. Surg. **38**:35-49, 1937. (*c*) Foulds, G. S.: Diagnosis of Perinephric Abscess, J. Urol. **42**:1-4, 1939. (*d*) Atcheson, D. W.: Perinephric Abscess with a Review of One Hundred and Seventeen Cases, ibid. **46**:201-208, 1941.

2. Gerota, D.: Beiträge zur Kenntnis des Befestigungsapparates der Niere, Arch. f. anat. u. Entwcklngsgesch., 1895, pp. 265-285.

clature, the surgical significance of Gerota's fascia in the spread of infection about the kidney and in the symptoms resulting therefrom need not be minimized. "Perinephritic abscess" has been suggested as applicable to those conditions secondary to primary disease in the kidney.[3] The long accepted use of the term "nephritis," however, for an entity not related to active suppuration in the kidney makes the use of the term "perinephritic" unfortunate because of the connotation. "Perirenal abscess" has often been employed in the past. The term should be abandoned because of its impure composition, since it is derived from both Greek ("peri-") and Latin ("renal"). "Perinephric abscess" is an adequate term if one qualfies it as either "simple" (due to metastatic infection involving the perinephrium directly or secondarily

TABLE 1.—*Classification of the Cases of Perinephric Abscess*

Group	Cases
I. Simple perinephric abscess	34
A. Without gross evidence of infection of the kidney *	25
B. With evidence of abscess or carbuncle of the kidney	9
II. Complicated perinephric abscess	33
A. Secondary to renal calculus and pyelonephritis	12
B. Secondary to severe pyelonephritis	8
C. Secondary to pyonephrosis	5
1. Due to ureteral calculus	2
2. Due to carcinoma of the prostate	2
3. Due to carcinoma of the bladder	1
D. Secondary to disease in the juxtarenal tissues	7
1. Tuberculosis of the spine	3
2. Actinomycosis of the lung and the spine	1
3. Amebic abscess of the liver	1
4. Appendical abscess	1
5. Ruptured diverticulum of the descending colon	1

* In this group was included a case secondary to rupture of the kidney.

from abscesses in the kidney) or "complicated" (due to acute or chronic infection in the kidney itself or in the juxtarenal tissues).

CLASSIFICATION OF PERINEPHRIC ABSCESS

A classification of perinephric abscess on an etiologic basis is the most convenient. The lesion is always secondary to infection elsewhere in the body. In this report, the lesions which have reached the perinephrium from distant foci by way of the blood stream or the lymphatics will be designated simple perinephric abscess. Included in this group will be those lesions in which infection has reached the perinephrium by extension from metastatic carbuncle or abscess of the kidney. Those reaching the perinephrium by direct extension from diffuse pyelonephritis or pyonephrosis or by direct or lymphatic extension from adjacent or nearby foci will be called complicated perinephric abscess. Table 1 is a classification of the cases to be described in this paper.

3. Vermooten, V.: The Mechanism of Perinephric and Perinephritic Abscess: A Clinical and Pathological Study, J. Urol. **30**:181-193, 1933.

INCIDENCE

Perinephric abscess is not a rare disease. On an active surgical service of some 100 beds at the Peter Bent Brigham Hospital, about 4 patients with perinephric abscess are treated each year.

TABLE 2.—*Symptoms of Sixty-Six Patients with Perinephric Abscess*

Symptoms	Cases
Pain	64 (out of 66)
Nausea and vomiting	35
Simple perinephric abscess	9 (out of 34)
Complicated perinephric abscess	18 (out of 24)
Urinary complaints	33 (out of 66)
Simple perinephric abscess	11 (out of 34)
Frequency and nocturia	6
Dysuria	5
Complicated perinephric abscess (due to acute and chronic sepsis in the kidney)	21 (out of 25)
Frequency and nocturia	18
Pyuria	9
Dysuria	5
Hematuria (due to juxtarenal disease)	1
Nocturia	1 (out of 7)

TABLE 3.—*Incidence of Antecedent Infection in Thirty-Four Cases of Simple Perinephric Abscess*

	Cases
Infections of the skin and the subcutaneous tissues	9
Acute infections of the upper part of the respiratory tract *	6
Pulmonary suppuration (bronchiectasis)	2
Thrombophlebitis with abscess formation	1
Postpartum infection	1

* In 1 of these cases there was severe tonsillitis.

TABLE 4.—*Age Incidence of Perinephric Abscess*

Type of Abscess	Mode	Youngest *	Oldest	Average
Simple	25 to 35 yr.	15 yr.	60 yr.	34 yr.
Complicated	40 to 50 yr.	22 yr.	77 yr.	47 yr.

* Patients under 12 were not admitted to the hospital.

TABLE 5.—*Laterality and Sex Incidence of Perinephric Abscess*

Type	Right	Left	Male	Female
Simple	21	13	24	10
Complicated	16	17	17	15
Due to calculi	6	6	4	8
Due to pyelonephritis *	4	5	2	6
Due to pyonephrosis	2	3	5	0
Due to juxtarenal disease	4	3	6	1

* One patient had bilateral perinephric abscesses.

Age.—The disease is uncommon in infants and children, presumably because these have as yet poorly developed perinephric tissues. In

adults, the age incidence differs with the type of perinephric abscess (table 4). The majority of cases of simple perinephric abscess occur between the ages of 25 and 35. Only 2 of the 34 patients were under 20. Complicated perinephric abscess, however, occurs most commonly in the late fourth and fifth decades. The patients in whom the abscess was secondary to pyonephrosis were all over 50 years of age (average age, 63).

Sex.—The statement is sometimes made that perinephric abscess is rare among female patients. The data from this study indicate the importance of segregating the cases into the two main groups, simple and complicated. In the former group, the ratio of male to female patients was 2½ to 1. In the group in which the abscess was secondary to renal calculi and to pyelonephritis, however, the ratio was reversed (table 5). Those secondary to pyonephrosis happen to have been all in male patients.

Laterality.—Simple perinephric abscess was nearly twice more common on the right side than on the left. In the complicated variety, however, the lesion was encountered on one side as frequently as on the other.

DIAGNOSIS

The diagnosis of perinephric abscess is made by integration of the data obtained from the history, the physical examination, the laboratory studies and the roentgen examinations.

History.—Early in the development of perinephric infection, the patient may have no specific complaints. He may recall that he had a skin infection or a severe infection of the upper part of the respiratory tract several days or even weeks before the visit and that he had felt "below par" ever since then. Anorexia, easy fatigability and night sweats are common early complaints.

A history of chills and fever was common. All the 34 patients with simple perinephric abscesses had objective fever, and 31 had complained of subjective fever. Seventeen of the 34 had had shaking chills one to several times. Among the 12 patients with perinephric abscess secondary to renal calculus, only 3 had had shaking chills. All complained of having been feverish, and all but 1 had objective fever. Of the 7 patients with abscess due to juxtarenal infection, 3 had had shaking chills. Five complained of subjective feverishness. Two had neither subjective nor objective fever.

Antecedent infection was recorded in 19 of the 34 cases of simple perinephric abscess (table 3). Twelve others of the 34 patients were found to have teeth "in wretched condition," but they had not complained of them. Perinephric abscess developed in 1 patient after

traumatic laceration of the kidney with extravasation of blood and urine but without a history of previous infection. The source of infection in the group of cases of complicated perinephric abscess is obvious. Whether the abscess formation in these cases was due merely to slow progression and extension of the renal infection or to flare-up of sepsis due to intercurrent infection could not be determined from this series. In 1 case, however, symptoms of perinephric abscess began one day after the onset of infection in the upper part of the respiratory tract.

Pain is the most common and sometimes the earliest specific symptom (table 2). It was absent in only 3 cases from the entire series of 66. These were complicated abscesses secondary to diabetic gangrenous pyelonephritis (1 case) and to obstructed pyonephrosis (2 cases). The pain was never colicky, but it did vary in intensity. In fact, it sometimes disappeared for periods of two or more days only to return with increased severity. Sometimes the pain was brought out only with motions of the trunk, with deep breathing or on coughing. Three patients in this series volunteered the information that the pain was relieved by flexing the thigh. Two of these kept the thigh flexed constantly.

The location of pain varied. Most commonly it was situated in the loin. The radiation of pain was of special interest because of its relation to the site of the lesion. Radiation of pain into the upper quadrant of the abdomen was especially common in those cases in which abscess was secondary to renal calculus. Six of 12 such patients complained of pain in the upper quadrant of the abdomen as well as in the loin and the costovertebral angle region. This may have been due to the almost uniform inflammatory involvement of the tissue about the renal pelvis both anteriorly and posteriorly in the presence of renal calculi. Two patients with simple perinephric abscess complained of pain in the ipsilateral shoulder. In these, the abscess overlay the upper pole of the kidney. Three patients complained of radiating pain down the anterolateral aspect of the thigh to the level of the knee due to irritation of the lumbar plexus by the perinephric abscess located posteromedially. In 2 other cases there was radiation of the pain into the ipsilateral testis.

In several cases, the pain radiated into the lower quadrant of the abdomen. Two patients with simple perinephric abscess complained of pain only in the right lower quadrant of the abdomen. One of these exhibited a palpable mass suggesting an appendical abscess. In each, the lesion involved the perinephrium anteriorly only.[4] These lesions are of special importance because of their not infrequent confusion with appendicitis.

4. Vergoz and Lenck: Du phlegmon périnéphrétique antérieur, J. d'urol. **47**:369-394, 1939.

Nausea and vomiting were common only in the cases of abscess secondary to chronic disease of the kidney. Of 26 patients with this condition, 20 complained of moderate to severe nausea and vomiting. On the other hand, among the 35 patients with simple perinephric abscess, only 9 had gastrointestinal complaints.

Urinary symptoms were uncommon in the cases of simple perinephric abscess. Of the 34 patients with this condition, only 6 complained of frequency and nocturia, and 5, of dysuria. These symptoms were never prominent. Likewise, among the patients with perinephric abscess secondary to juxtarenal disease, only 1 complained of occasional nocturia. Of 25 patients with complicated perinephric abscess with primary disease in the kidney, however, 21 had prominent urinary symptoms (table 2). It appears, then, that perinephric abscess does not cause urinary symptoms but that when these are present, they are secondary to infection within the urinary tract itself.

Loss of weight is often a prominent observation in patients ill with perinephric abscess. This is true not only of those in whom chronic renal infection has existed for a long time but also among those with simple perinephric abscess of relatively short duration. One patient with perinephric abscess secondary to renal calculus had lost 60 pounds (27.2 Kg.) during the preceding year and 33 pounds (15 Kg.) during the preceding month. A 32 year old previously robust woman lost 32 pounds (14.5 Kg.) during the six weeks before admission to the hospital, and a 26 year old physician lost 25 pounds (11.3 Kg.) during an illness of only four weeks.

Physical Findings.—The patient with perinephric abscess looks acutely ill. This is particularly true of those with simple perinephric abscess. In the group with complicated abscess, the picture is more one of chronicity and debilitation, owing to the combined effects of prolonged sepsis and renal insufficiency. Night sweats are the rule; the skin presents a pasty pallor. In the acute condition the patient is apprehensive; those with complicated perinephric abscess are often apathetic. Toxicity and prostration characterize the former group; wasting, apathy and even coma characterize the latter. Patients with complicated abscess who present themselves during an acute exacerbation of nephric and perinephric infection, however, may show a degree of toxicity equal to that of patients with acute simple perinephric abscess.

Temperature: The degree of fever in patients with perinephric abscess is variable. The morning temperature is sometimes normal, but it rises in the afternoon and the evening to a level varying between 102 and 106 F. orally. It is generally not spiking, however, except during the early phase of the disease—probably before inflammatory fixation has taken place.

Pulse Rate: Occasionally, the pulse rate of patients with perinephric abscess was recorded as within normal limits. Usually, however, depending largely on the severity of the infection and the debility of the patient, the pulse rate was elevated to as high as 140. It was seldom below 90.

Tenderness: Tenderness was the most common finding on physical examination. Among the 34 patients with simple perinephric abscess, 24 had tenderness on pressure in the costovertebral angle, on pressure on the twelfth rib and sometimes on pressure over the eleventh rib. Nine of the 10 remaining patients in this group exhibited tenderness in the loin. The other had tenderness only in the right lower quadrant of the abdomen extending outward toward the flank. This was a patient with an anterior perinephric abscess due to beta hemolytic streptococci following an acute infection of the upper part of the respiratory tract.

In 13 of the 34 cases of simple perinephric abscess, tenderness extended into the upper part of the abdomen. In 7, it was found in the lower part. These are the cases in which the possibility of cholecystitis and appendicitis must be ruled out.

Tenderness was an equally prominent finding in patients with complicated perinephric abscess. It was most commonly located in the flank and the costovertebral angle. Tenderness in the lower part of the abdomen was found in only 2 cases.

Spasm: Twenty-two of the 34 patients with simple perinephric abscess showed spasm in the flank. Nine of these had spasm in the region of the costovertebral angle as well. Most of the patients with tenderness extending into the upper and lower parts of the abdomen also had spasm in these areas, but the degree of this was variable.

Except in the cases secondary to juxtarenal disease, spasm was not as prominent in patients ill from complicated perinephric abscess. This may have been due to chronicity of the disease and relatively greater debility of the patients. Of the 7 patients with perinephric abscess complicating adjacent infection, however, 6 showed both tenderness and spasm in the flank.

Palpable Mass: Visible swelling in the loin was observed in 21 of the 34 cases of simple perinephric abscess, in 6 of the 12 cases secondary to renal calculus, in 3 of the 8 cases due to pyelonephritis without calculus and in 3 of the 7 cases complicating juxtarenal disease. A distinct mass, however, was palpable in only some of these, i. e., in about one third of the cases of simple abscess and half the cases due to renal calculus (table 6). Each 1 of 8 patients with abscess due to pyelonephritis showed a palpable mass on physical examination even though there was no visible swelling in the flank. Occasionally, edema and tenderness were observed in the skin, and subcutaneous tissue overlying

the mass was noted. Of special interest is the fact that a large proportion of the palpable masses moved with respiration (table 6). Abscesses in other locations, such as appendical abscess, are usually fixed. In cases of perinephric abscess, mobility of the mass probably indicates the presence of relatively free layers of paranephric fat.

Changes in the Diaphragm: Physical examination of the chest revealed elevation of the ipsilateral diaphragm in 7 cases. Three of these cases were among the 12 patients in whom the disease was secondary to renal calculus. The others were among the patients with simple perinephric abscess. In all but 1 the abscess involved the perinephrium overlying the upper pole of the kidney.

Scoliosis: Curvature of the spine with concavity toward the side of the lesion due to spasm of the paravertebral muscles has been emphasized as a prominent sign of perinephric abscess. Scoliosis was detected clinically in only 4 of the 66 cases of perinephric abscess. They were all in patients with simple abscesses. One of them walked with an obvious list toward the affected side. By roentgen examination,

TABLE 6.—*Palpable Mass in Perinephric Abscess*

Group	Cases	Visible Swelling	Palpable Mass	Movable Mass
Simple	34	21	10	1
Complicated	32	14	18	7
Due to renal calculus	12	6	6	4
Due to juxtarenal infection	7	3	3	1
Due to pyelonephritis	8	5	8	2
Due to pyonephrosis	5	0	1	0

definite mention of scoliosis was made in only 2 cases. It seems, then, that though of significance when found, scoliosis is one of the less common signs of perinephric abscess.

Spasm of the Psoas Muscle: The proximity of the psoas muscle to the perinephrium renders it especially subject to involvement by inflammatory reactions about the kidney. The frequency with which patients volunteered the information that they were more comfortable with the thigh flexed has already been mentioned. Yet gross evidence of spasm in the psoas muscle was encountered only seldom. In this series it was recorded in only 2 of the 66 cases. In 1 patient, the perinephric abscess was secondary to inflammation and perforation of a diverticulum of the descending colon; in the other, it was secondary to acute and chronic pyelonephritis. The latter patient had to keep her thigh constantly flexed for relief of pain.

Roentgen Examination.—The information secured by roentgen examination of the patient suspected of having perinephric abscess is an important adjunct, when properly interpreted, to the data obtained

by other methods of investigation. However, none of the accepted roentgen signs of perinephric abscess is sufficiently pathognomonic to rule the lesion in or out. Perinephric abscess may exist in the absence of any abnormality in the roentgen film or may be absent in the presence of one or more signs known to accompany the lesion.

The incidence of positive roentgen findings is recorded in table 7. It will be noted that among the cases studied, in about one third there was no definite abnormality in the roentgenogram of the abdomen. Indistinctness of the ipsilateral psoas margin with a normal shadow on the opposite side was the most common finding in both the simple and the complicated types of abscess. Elevation of the diaphragm was found in 5 of the 28 cases of simple perinephric abscess and in 6 of the 12

TABLE 7.—*Roentgen Findings in Sixty-One Cases of Perinephric Abscess*

Type	Total	Patients Studied Roentgenologically	Negative Kidney, Ureter and Bladder Film	Obliteration of Psoas Shadow with Opposite Side Normal	Elevation of Diaphragm with Limitation of Respiratory Excursions	Pyelographic Changes	Scoliosis	Soft Tissue Mass in the Flank
Simple	34	28	10	8	5	6	2	0
Without abscess of the kidney	25	21	8	6	4	4	1	0
With abscess of the kidney	9	7	2	2	1	2	1	0
Complicated	27	23	5	5	4	..	1	4
Secondary to renal calculi	12	11	0	2	4	Associated with calculus	0	2
Secondary to pyelonephritis	8	5	2	0	0	..	0	1
Secondary to juxtarenal infection	7	7	3	3	0	..	1	1

cases of complicated abscess secondary to renal calculi. In all of them, the lesion was either localized to the region overlying the upper pole of the kidney, or it involved the perinephrium diffusely about the kidney in addition to the region adjacent to the upper pole. Two of the patients with an elevated diaphragm showed a small pleural effusion on the same side.

Pyelographic Examination: Excretory pyelograms demonstrated changes in 6 of the 10 cases of simple perinephric abscess in which the test was made. The abnormalities recorded were distortion of the calices to resemble polycystic disease of the kidney, rotation of the kidney in either its horizontal or vertical axis, lateral or medial displacement of the kidney and the upper end of the ureter and compression of the calix and the renal pelvis (due to carbuncle of the kidney).

Similar changes were seen in roentgenograms of patients with perinephric abscesses secondary to renal calculi. Of special interest is the fact that in 2 of the 11 cases studied, the renal shadow on the affected side was described as abnormally small. In 7 of the 28 cases of simple perinephric abscess studied, however, the renal shadow was abnormally large. Soft tissue masses were visualized in 4 of the patients with complicated perinephric abscess but in none of those with simple perinephric abscess. Positive findings were obtained in 4 of the 7 cases secondary to juxtarenal disease (table 7).

Laboratory Data.—Urinalysis: In table 8 are recorded the findings on examination of the urine of 66 patients with perinephric abscess. Here again it is important to note the differences among the various types of perinephric abscess. Abnormalities are least frequent in patients with simple perinephric abscess who at operation had no gross evidence

TABLE 8.—*Urinalysis in Cases of Perinephric Abscess.**

Type of Abscess	Albumin					White Blood Cells †					Red Blood Cells †				
	0	+	2+	3+	4+	0	+	2+	3+	4+	0	+	2+	3+	4+
Simple (24 cases)															
Without evidence of abscess in the kidney	24	0	0	0	0	9	5	8	2	..	17	7	..	..	..
With abscess in the kidney	6	1	2	..	..	1	8	..	..	..	2	6	..	..	..
Complicated															
Due to renal calculus (12 cases)	1	1	1	9	..	0	2	10	..	..	1	6	3	2	..
Due to pyelonephritis (8 cases)	2	6	..	..	..	..	..	..	8	..	..	..	..	4	..
Due to juxtarenal disease (7 cases)	4	1	1	1	..	3	3	..	1	..	5	1	1	..	..

* Cases secondary to pyonephrosis not included.
† 0 = none; + = scarce; 2+ = few; 3+ = many; 4+ = very many.

of abscess in the kidney itself. None of these patients, for instance, showed albuminuria; only 7 of them showed a rare red blood cell in the urinary sediment, and 15 showed rare to many white blood cells.

The urine of patients who at operation showed evidence of renal involvement, however, showed relatively more abnormal elements in the urine. Two thirds of them had albuminuria, and all but 1 showed at least some white blood cells in the urine. The greatest abnormality was found in the urine of patients with complicated perinephric abscess (table 7).

Cytologic Character of the Blood: Hypochromic anemia was found frequently, particularly in the patients with complicated perinephric abscess. These had been ill for longer periods, and the anemia was correspondingly more prominent.

The white blood cell count was almost invariably elevated. A normal count was obtained in only 1 patient. She was extremely ill with

perinephric abscess secondary to pyelonephritis, and examination of the blood smear showed 92 per cent polymorphonuclear cells with a marked shift to the left. In cases of simple perinephric abscess without evidence of abscess in the kidney, the average white blood cell count was 19,500; in the cases in which there was abscess in the kidney itself, the average white blood cell count was 14,200. The highest count in the group with simple perinephric abscess was 40,000. Higher white blood cell counts were obtained in patients with complicated perinephric abscess. The highest was 84,000 cells per cubic millimeter (obtained repeatedly and in the absence of leukemia); it was that of a patient with perinephric abscess and renal calculi. The next highest count (56,900) was that of a patient with perinephric abscess secondary to pyelonephritis without calculi.

TABLE 9.—*Bacteriologic Findings in Sixty-Six Cases of Perinephric Abscess*

Group	Cases	Staph. Aureus	Staph. Albus	B. Coli	Mixed	Str. Haemolyticus	Nonhemolytic Streptococcus	Tuberculosis	Actinomycosis	Cases in Which Blood Cultures Were Made	Cases in Which Blood Cultures Were Positive
Simple perinephric abscess	34	23	4	0	0	2	1	..	..	8	1
Without abscess of the kidney	25	17	2	0	0	..	..	..	..	5	0
With abscess of the kidney	9	6	2	0	0	..	..	..	..	3	1
Complicated perinephric abscess	32	1(?)	1	14	6	..	..	..	..	5	0
Due to renal calculus	12	1(?)	..	6	2	..	..	..	..	2	0
Due to pyelonephritis	8	..	1	5	..	..	..	1	..	1	0
Due to pyonephrosis	5	..	..	2	1	..	..	..	..	1	0
Due to juxtarenal disease	7	..	..	1	2*	—	—	3	1	1	0

*See text.

All the patients showed an increase in the proportion of polymorphonuclear cells in the blood. The majority showed a differential count of 85 to 90 per cent polymorphonuclear white blood cells. The highest was 97 per cent. The erythrocyte sedimentation rate was determined in 2 patients and was markedly elevated in both.

Bacteriologic Findings.—Culture of the perinephric pus from patients with simple perinephric abscess showed bacteria almost always in pure culture. The most common organism recovered was Staphylococcus aureus (in 23 of the 34 cases of simple perinephric abscess). Staphylococcus albus was recorded in 4 of the other 11 cases. In 2 cases a growth of beta hemolytic streptococcus was obtained, and in 1 case, nonhemolytic streptococci were cultured. No bacteriologic data were available for 3 patients, and in 1 instance there was no growth in cultures of the exudate in routine mediums.

Cultures were made of the venous blood of 8 patients with perinephric abscess, without renal involvement in 5 and with abscess of the kidney in 3. None of the former were positive; among the latter, 1 showed a growth of Staph. aureus and Bacillus coli, and 2 were sterile.

Cultures of the pus from perinephric abscesses secondary to calculus disease of the kidney showed B. coli in pure cultures in 6 of the 12 cases. In 2 other cases, this organism was found together with staphylococcus (Staph. aureus in 1 and Staph. albus in the other). No growth was obtained in the culture from 1 case. The colon bacillus was likewise the predominating organism in the case secondary to noncalculous pyelonephritis and to pyonephrosis (table 10).

In the cases secondary to juxtarenal disease, the organisms cultured were the same as those in the primary lesions. Two of the 7 patients showed B. coli (1 in conjunction with an unidentified coccus). Three

TABLE 10.—*Morbidity in Sixty-Six Cases of Perinephric Abscess*

Type of Abscess	Simple Perinephric Abscess		Complicated Perinephric Abscess			
	Without Abscess of the Kidney	With Abscess of the Kidney	Due to Renal Calculi	Due to Pyelonephritis	Due to Pyonephrosis	Due to Juxtarenal Disease
Operations	1 to 2	1 to 3	1 to 3	1 to 2	1 to 2	1
Average number of days in the hospital postoperatively	24	60	53	25.5	73 to 99 †	40
Mortality (percentage of subgroup)*	0	0	33	50	50‡	14

* Deaths due to uremia because of progressive irreparable damage to the kidneys have not been included in this group. The perinephric abscess in these cases was only a minor incident. A patient with perinephric abscess and carbuncle of the kidney accompanying brain abscess and purulent (Staph. aureus) meningitis also has been excluded.

† Includes only the 2 patients who were operated on.

‡ Only 2 of the 5 patients in this group could be considered suitable for this analysis. One died after drainage first of the abscess and then of the kidney. The other was cured after incision and drainage of the abscess followed by nephrectomy.

cases were due to tuberculosis, and 1 patient showed a mixed growth of Streptococcus haemolyticus and Staph. aureus. Endamoeba histolytica was the causative agent in 1 case secondary to amebic abscess of the liver, and actinomyces was recovered from another patient.

TREATMENT OF PERINEPHRIC ABSCESS AND RESULTS

Six patients suspected of having had perinephric abscess were not included in the analysis just given because they recovered without operation and the diagnosis consequently was never proved. None returned to the hospital for recurrence of symptoms. These and similar cases reported in the literature indicate that spontaneous healing of perinephric abscess may occur, but it is the exception rather than the rule.

In 22 of the 24 cases of simple perinephric abscess without carbuncle of the kidney, the disease was cured by mere incision and drainage of the abscess. In 1 case, however, revision of the wound was required

to improve drainage, and in the other (secondary to traumatic injury of the kidney) nephrectomy was required twenty-six days after incision and drainage of the abscess.

Seven of the 9 patients who had perinephric abscess accompanied by abscess in the kidney were cured by simple incision and drainage. One of the 9 required nephrectomy five months after the initial incision and drainage because of persistent sepsis in the kidney. One of the patients in this group died without operation. He was a patient in whom a small (2.5 cm.) perinephric abscess and a cortical abscess of the kidney complicated Staph. aureus and B. coli bacteremia following sepsis in a laparotomy wound and thrombophlebitis with abscess formation in the leg. In addition, he had chronic glomerulitis and died in uremia.

Nephrectomy was done more frequently in the patients ill with complicated perinephric abscess. Four of the 12 patients with abscess secondary to renal calculus were treated by primary nephrectomy. Of these, 2 died—1 because of laceration of the diaphragm; the other because of persistent sepsis which eventually led to thrombophlebitis of the splenic vein and multiple liver abscesses. Four of the 12 patients were treated by incision and drainage followed by nephrectomy three weeks to three months later. All were cured of their disease.

Four patients with perinephric abscess secondary to renal calculi died after only incision and drainage of the abscess had been done. One was a 29 year old man who died of overwhelming infection twenty-five days after operation. His condition had apparently never been sufficiently good to warrant nephrectomy. One patient was 52 years old and died of a coronary attack during operation. Another was a 72 year old woman who recovered from incision and drainage of the abscess and was discharged home to continue her convalescence preparatory to secondary nephrectomy. She died at home a month later of coronary thrombosis. The fourth patient died in uremia shortly after revision of a draining sinus which had persisted after an operation for perinephric abscess three years previously. A similar patient with a draining nephrectomy sinus died in uremia without operation. She was 44 years old and had had renal calculi removed seven years previously.

All of the patients with perinephric abscess secondary to acute and chronic pyelonephritis were operated on. Four of the 8 were cured of the disease after nephrectomy. On 1, nephrectomy was done as a primary procedure; on the other 3 as a secondary operation eleven days, three and a half months and nine months after simple incision and drainage of the abscess. In the 4 that died, simple incision and drainage of the perinephric abscess was the only operative procedure except on the 2 patients with fulminating diabetic pyelonephritis (or gangrene of the kidneys), on whom in addition nephrostomy was done. The deaths are described in table 11.

TABLE 11.—*Hospital Deaths from All Causes Among Sixty-Six Patients with Perinephric Abscess*

	Age	Sex	Operation	Interval Between Operation and Death	Autopsy	Comments
Simple Perinephric Abscess with Abscess in the Kidney						
1*	50	M	None	.....	Yes	Cortical and perinephric abscesses were found only at postmortem examination; they were merely incidental to bacteremia and overwhelming sepsis from which the patient died (see text)
2*	40	M	Incision and drainage of perinephric abscess	5 days	Yes	In this patient the renal and perinephric abscess accompanied brain abscess and purulent meningitis from which he died; all the lesions were secondary to chronic bronchiectasis
Complicated Perinephric Abscess						
A. Due to Renal Calculi						
1	47	M	Nephrectomy on the right	.....	Yes	Laceration of the diaphragm with perforation into the pleural cavity was the contributing cause of death
2	29	F	Incision and drainage of abscess	25 days	No	Died of persistent severe sepsis
3	57	F	Incision and drainage of absces	Operative death	Yes	Patient died at close of operation; spinal anesthesia was used; cause of death not determined
4*	61	F	Revision of chronic draining sinus leading to abscess about the lower pole of the kidney	6 hours	Yes	Stones had been removed from the kidney 3 years previously; persistent sinus ever since; uremia from progressive renal failure; operation was done only as a last resort
5*	44	F	None	.....	Yes	Perinephric abscess drained elsewhere, 7 years previously; persistent sinus ever since; progressively downhill uremic course during 6 weeks in the hospital
6	32	F	Nephrectomy	3 months	Yes	Died of persistent sepsis with thrombophlebitis of the splenic vein and multiple abscesses of the liver
B. Due to Pyelonephritis						
1	21	M	Incision and drainage	3 days	No	Patient was ill with an unclassified hemorrhagic diathesis; kidney described as necrotic when abscess was incised and drained
2	61	F	Incision and drainage	Died during operation	No	Patient died, apparently of coronary thrombosis
3	46	F	Incision and drainage with nephrostomy	6½ hours	Yes	Patient had severe diabetes; kidneys actually gangrenous; progressive uremia; moribund before operation
4	46	F	Incision and drainage with nephrostomy	24 hours	Yes	Severe diabetes; acute and chronic pyelonephritis with bilateral multiple abscess formation; progressive uremia; operation done as last resort
C. Due to Pyonephrosis						
1	62	M	1. Incision and drainage 2. Revision of wound and drainage of kidney	74 days after first and 24 days after second operation	Yes	Fecal fistula complicated incision and drainage of the abscess
2*	54	M	None	.....	Yes	Died of perforation of carcinoma of the bladder into the general peritoneal cavity
3*	70	M	None	.....	Yes	Died of renal failure with pyonephrosis and bilateral pyelonephritis; right perinephric abscess was incidental
4*	77	M	None	.....	Yes	Carcinoma of the prostate; bilateral pyonephrosis; cortical abscess of both kidneys with perforation into the perinephrium on the left; progressive uremia was the cause of death
D. Due to Juxtarenal Disease						
1	60	M	1. Incision and drainage of perinephric abscess 2. Drainage of iliopsoas abscess	43 days	Yes	Abscess was secondary to perforation of the diverticulum of the descending colon; fecal fistula developed 3 days before death; died of persistent sepsis and progressive debility

* Not included in mortality statistics.

The patients with perinephric abscess secondary to juxtarenal disease were all treated by incision and drainage alone. In 1 patient, sepsis extended along the iliopsoas bursa and required drainage through the thigh in Scarpa's triangle. Only 1 of the 7 patients died while still in the hospital. This case was secondary to perforation of a diverticulum of the descending colon. Of the other 6 patients, however, 3 died later of their primary disease: tuberculosis of the spine with meningitis (2 patients) and actinomycosis of the spine and the lungs (1 patient).

MORBIDITY AND MORTALITY RATES

Morbidity and mortality statistics in the 66 cases of perinephric abscess are compiled in tables 10 and 11. The long period of hospitalization necessary for these patients emphasizes the economic aspects of the disease. Surgical lesions which necessitate hospitalization for two months are relatively few.

The mortality rates associated with perinephric abscess should be interpreted in relation to the type of abscess. Among patients with simple perinephric abscess, for example, the mortality in this series was nil, if the 2 patients are excluded who died from causes other than the effects of the suppuration in the perinephrium. In complicated perinephric abscess, however, the mortality rate may be as high as 14 to 50 per cent. For the entire group, the mortality rate attributable to perinephritic abscess was 15 per cent.

COMMENT

It is generally agreed that simple perinephric abscess is almost always secondary to infection elsewhere in the body. The primary focus may be trivial infection in the skin, the upper part of the respiratory passages or elsewhere. The path by which the perinephrium is infected, however, has been disputed.[5] In this connection, 25 cases of simple and multiple abscesses of one or both kidneys were reviewed. In these there was no evidence of perinephric abscess on postmortem examination. It should be pointed out, however, that tiny isolated abscesses in the perinephrium may be missed in routine autopsies.

Of the 2 patients with simple perinephric abscess with simultaneous involvement of the kidney on whom autopsy was performed, 1 showed no connection between the two lesions. In the other, the kidney appeared to have been involved from without. Two patients with complicated perinephric abscess, however, showed direct communication between the cortical and the perinephric abscesses through the true capsule of the kidney. It appears, then, that bacteria may reach the perinephrium

5. Birdsall, J. C.: Perinephric Abscess, J. Urol. **25**:405-412, 1931. Vermooten.[3] Mathé.[1b] Atcheson.[1d]

either by extension from abscesses in the kidney or directly from the blood stream. To be sure, bacteria are less apt to lodge in the poorly vascularized perinephrium than in the kidney with its excellent circulation. On the other hand, this very difference in vascularity favors growth and exhibition of virulence by bacteria which do happen to reach that region even if in small numbers.

Analysis of the data just recorded emphasizes the importance of attention to the history and the physical examination of patients with perinephric abscesses in order to arrive at an early diagnosis. Roentgenograms and laboratory data are only corroborative. Fixation of the kidney and the diaphragm has been emphasized by Mathé as an additional roentgen sign of perinephric abscess. When present, it indicates diffuse phlegmon and suppuration in the perinephrium or a localized abscess in the neighborhood of the upper pole of the kidney. Abscesses about the lower pole of the kidney, however, or anteriorly in the perinephrium, may not show this sign. In 1938, Menville [6] reported anterior displacement of the kidney by perinephric abscess. Here, again, abscesses situated anteriorly may not displace the kidney. Furthermore, great care must be taken in exposing true lateral films, for even slight departures from the true lateral may project the renal shadow far from its expected position so as falsely to suggest displacement of the kidney.

Although of minor importance in establishing a diagnosis of perinephric abscess, urinalysis may yield important data. It will be seen from table 8 that in cases of simple perinephric abscess the presence of albumin and white blood cells in the urine indicates gross involvement of the kidney itself by the suppurative process. Such data are thus useful in prognosticating morbidity (table 10).

The mischievous morbidity of perinephric abscess has been emphasized by many writers. Three factors promote the complications and delayed convalescence of the disease:

(*a*) Failure of Early Diagnosis: Perinephric abscess is usually so insidious that patients do not often present themselves early in the course of the disease. Instead, they appear after symptoms have progressed for days or months. Even after hospitalization, considerable time is often spent before a diagnosis is established. In this series of 66 patients, only 2 were operated on the day of admission. In an exceptional case, operation was not performed until one hundred and twenty-four days after hospitalization. The average delay was five and a half days.

Undue delay in the diagnosis and the drainage of perinephric abscess prolongs convalescence and increases the hazards of the disease because of extension of the lesion more and more widely through the perinephrium until neighboring structures are involved. Portal

6. Menville, J. G.: The Lateral Pyelogram as a Diagnostic Aid in Perinephric Abscess, J. A. M. A. **111**:231-233 (July 18) 1938.

thrombophlebitis, intestinal fistulas, involvement of the iliopsoas bursa and extension into the pleural cavity through the diaphragm have occurred. Early drainage should prevent such complications. Sufficient delay, under observation, to permit localization of the inflammatory lesion, however, is undoubtedly beneficial. The duration of the delay must be guided by the clinical course of the patient and seldom needs to be more than two to five days. During this time, sulfathiazole 2-[para-aminobenzenesulfonamido]-thiazole) or sulfadiazine (2-[paraaminobenzenesulfonamido]-pyrimidine) may be administered. It is always advisable to delay surgical intervention as long as the patient continues to improve with chemotherapy and supportive treatment.

Perusal of hospital records often fails to reveal the cause for delay in diagnosis. Study of the progress notes, however, has indicated that the most common cause for delay is failure to consider the lesion as a possibility in the differential diagnosis. In some cases, the diagnosis is considered but then discarded because of the lack of gross physical findings or the presence of mobility in the palpable mass. It should be emphasized that physical signs may be minimal when the abscess has not penetrated the perinephric fascia of Gerota and that the palpable mass may be movable before the inflammation has extended through the paranephric fat.

The differential diagnosis in patients with obscure fever and particularly with pain in the loin should always include perinephric abscess with or without abscess of the kidney. Additional findings in the history and the physical examination serve to strengthen or weaken the impression.

(*b*) Architecture of the Perinephrium: The fibrofatty structure of the perinephrium with its many interlacing fibrous trabeculae favors neither prompt and complete localization of the inflammatory process nor rapid resolution following drainage. When the kidney itself is involved, its functional activity may play a role in delaying healing.[7] Finally, the relations of the perinephrium to the rib cage and the kidney sometimes make adequate drainage difficult to effect, and revision of wounds to facilitate drainage is therefore sometimes necessary.

(*c*) General Condition of the Patient: Patients ill because of complicated perinephric abscess are usually in poor general condition. The underlying disease has often been present for months or years, and the patients always show evidence of prolonged sepsis. Simple perinephric abscess is of relatively short duration, but the virulence and the toxicity associated with the infection in these cases are such as to

7. The postoperative hospital stay of patients with perinephric abscess in whom there was no evidence of renal involvement was eight to sixty-one days (average, twenty-four); that of patients in whom the kidney was grossly involved was twenty-nine to one hundred and thirty-seven days (average, sixty-nine).

cause severe debilitation. Metabolic processes are disturbed; immunity is inhibited; wound healing is impaired, and convalescence is delayed.

Early diagnosis, adequate preoperative preparation, attention to technical details at operation and careful supportive postoperative treatment should decrease the morbidity and mortality rates of perinephric abscess to a minimum. Operative technic must be guided by the general principle of establishing and maintaining adequate drainage with the least possible trauma. Acid-cured tubes of gum rubber have been more serviceable than cigaret wicks. In 1941, Atcheson reported good effects from counterdrainage. This may prove useful in isolated instances.

Tight closure of the wound about the drain should be avoided. Wounds have been found to heal more quickly when bottlenecking is avoided. Meticulous care of the wound to avoid maceration and spread of infection is an exercise in surgical dressing. Postoperatively, the patient should be assured comfort, nutrition and hydration.

Exactly how far one should proceed at the time of the primary operation for incision and drainage of perinephric abscess is a disputed point. It is generally agreed that when nephrectomy is indicated, as in cases secondary to pyelonephritis or to renal calculi, it is best done at a second stage, at least two, and preferably more, weeks after the first operation. Whether or not nephrostomy should be done in these patients must be determined by the presence or absence of obstruction to the outflow of urine from the kidney. Careful judgment should be exercised in the question of the extent of exploration advisable in cases of simple perinephric abscess. It is best to do as little as is consistent with adequate drainage of the abscess at the first operation. It is important not to break the barriers within the perinephrium, which have localized the abscess, in an attempt to explore the entire kidney in search of lesions within it. A secondary operation for drainage of the kidney or for nephrectomy is far preferable to overzealous exploration at the first operation. However, patients must not be neglected after primary operations. Thus, 2 patients whose cases are recorded in table 11 who died as the end result of the complications of calculus disease of the kidney might possibly have had a different outcome had nephrectomy been done at the appropriate interval after the original operation.

The high mortality rate associated with complicated perinephric abscess deserves special mention. The fact that there is such a striking difference between the mortality rate with this type of abscess and that with simple perinephric abscess suggests that causes other than the perinephric abscess are responsible for the deaths. These causes have been listed in table 11. For purposes of prognosis, therefore, the nature of the underlying disease is of greater importance than the perinephric abscess itself.

CONCLUSIONS

Perinephric abscess must be considered in the differential diagnosis of fever and pain in the loin or the flank.

The diagnosis is usually made by the history and the physical examination; roentgenograms and laboratory data are corroborative.

Fever, leukocytosis, elevated erythrocyte sedimentation rate and loin tenderness are almost constant findings.

The side affected, the sex incidence and the age incidence depend on the type of abscess.

Abnormalities in the urine indicate involvement of the kidney in the suppurative process.

The importance of adequate drainage of perinephric abscess with as little derangement as possible of the body defenses has been emphasized.

When nephrectomy is indicated, it is most safely done as a secondary operation.

Morbidity and mortality statistics are significant only when considered in relation to the type of abscess.

With simple perinephric abscess, the mortality rate is nil; with complicated perinephric abscess, it varies between 14 and 50 per cent.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1941

A REVIEW PREPARED BY AN EDITORIAL BOARD OF THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

PREFACE

In the preparation of "Progress in Orthopedic Surgery for 1941" the titles of 2,397 articles of orthopedic interest were gathered from the *Quarterly Cumulative Index Medicus* for 1941. The number of articles reviewed in the final report is 824, or 34 per cent of the total. The editor of each section has selected the articles which he thinks have the greatest scientific interest and represent the most progress. The chairman of the editorial board has reviewed the material prepared for each section and has made certain additions and changes which seemed indicated to improve the publication as a whole.

On account of the war and the consequent added interest in fresh fractures and dislocations, it was thought advisable to publish the section dealing with this subject first. In addition there will be found throughout the publication many abstracts and references pertinent to military medicine. It is hoped that these will act as guides in improving the treatment of soldiers and sailors in the hospitals of our armed forces.

The style of every section is not uniform, and the number of editorial comments (which form so valuable a part of the publication) is not always the same. Both style and comments have again been left to the discretion of the editor of each section except for a few changes made by the chairman of the editorial board. Again we must state what was prefaced to the "Progress in Orthopedic Surgery for 1940":

> . . . If the reader or the author of any article does not agree with the editorial comment, the editorial committee hopes that he will think of the remark as only one man's impression and as in no way representing the opinion of the entire editorial board.

It was thought advisable this year to appoint an assistant editorial board made up of members of the Academy. This was done, and the names of the members are listed accordingly.

The editorial committee wishes to express its appreciation to the group of physicians who although not members of the Academy have rendered valuable assistance to the editorial board in the preparation of the material for the different sections and to the editorial staff of the ARCHIVES OF SURGERY for its splendid cooperation in the publication of the material.

The members of the editorial board are as follows:

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The editorial committee believes that the "Progress for 1940" has proved an acceptable addition to the orthopedic literature and hopes that this 1941 edition may also be a publication of great usefulness to those interested in the problems of orthopedic surgery.

(Signed) The Editorial Committee of the
American Academy of Orthopaedic Surgeons.
REX L. DIVELEY, M.D.
E. BISHOP MUMFORD, M.D.
A. R. SHANDS JR., M.D., *Chairman.*

I. FRESH FRACTURES AND DISLOCATIONS

Fractures and Dislocations of the Head of the Humerus.—Rendich and Poppel [1] have combined the results of clinical and dissecting room work to describe the unusual condition of posterior dislocation of the shoulder joint. They divide the condition into subacromial and subspinous types. It seems from their discussion that the dislocation is most commonly produced by forcible internal rotation of the shoulder causing a rupture of the posterior capsule. This happens most commonly in convulsive seizures, such as those of epilepsy. The authors indicate special diagnostic points but point out that a stereoscopic view of the shoulder shows the dislocation. A vertical view demonstrates the posterior displacement. They explain in some detail the findings which are suggestive of the condition on a single flat plate. [ED. NOTE: The diagnostic points on a flat plate seem to lose a great deal of importance when it is demonstrated by the authors that stereoscopic or vertical views permit immediate diagnosis.]

Moorhead [2] discusses fractures of the surgical neck of the humerus, dividing them into two types: those in which the apposition of the fragments is approximately 50 per cent or less and those in which there is no apposition. He says that the relation of the head of the humerus to the glenoid cavity is more important than that of the head to the shaft. He emphasizes the dangers of increasing the displacement by attempting to secure more perfect reduction. The treatment recommended is the use of a sling or one of its modifications with early active and passive motion to prevent adhesions about the shoulder joint. [ED. NOTE: This is a practical discussion of the treatment of a fracture which at times is difficult to reduce.]

Geckeler [3] reports 15 cases of fracture of the surgical neck of the humerus. He makes the comment that most of these fractures will heal under any form of treatment. He feels that formerly too much attention was paid to the anatomic reposition of the fragments and that not enough attention was given to the function of the arm; this resulted in adhesions and contracture following prolonged immobilization. He calls attention to the following observations of other authors recently reported in the literature: 1. The fragments will remain in relatively normal position after reduction provided the arm hangs at the side with

1. Rendich, R. A., and Poppel, M. H.: Roentgen Diagnosis of Posterior Dislocation of the Shoulder, Radiology **36**:42-45 (Jan.) 1941.

2. Moorhead, J. J.: Conservative Treatment in Fractures of Neck of Humerus, Connecticut M. J. **5**:267 (April) 1941.

3. Geckeler, E. O.: Treatment of Fractures of Neck of Humerus Without Immobilization, Surgery **10**:917-926 (Dec.) 1941.

no support under the elbow (hanging traction). 2. The longitudinal muscles exert a squeezing effect on the fragments. 3. The tendon of the long head of the biceps brachii muscle controls the upper fragment, and the weight of the arm causes traction on this tendon. Geckeler's method of treatment is to place the arm in a sling and start active exercise immediately. In all 15 cases union was obtained in eight weeks. He recommends this method for all fractures of the neck of the humerus except those with which there is dislocation or decided displacement. [ED. NOTE: This is another modification of treatment by a hanging cast. The author reports excellent results with the use of only the weight of the arm for traction.]

Fractures of the Shaft of the Humerus.—Griswold, Hucherson and Strode [4] present the end results of treatment by a hanging cast in 305 cases of fracture of the humerus. Exceptions to the use of this method are listed as extension supracondylar fractures in children and extensive compound fractures which require early skeletal traction.

The principle of this form of treatment depends on traction exerted in the line of the humerus by the weight of the plaster cast extending from the knuckles to the axillary fold with the elbow at right angles. The cast is allowed to hang free on the sling around the neck; the sling is attached to a loop of wire incorporated in the cast at the wrist. When in bed, the patient should be kept in the Fowler position for the first week so that constant traction is maintained. Circumduction exercises of the shoulder are used from the beginning to minimize limitation of shoulder motions and muscular atrophy. Analysis of the group of cases reported shows an average age of 43.5 years and an average length of time of plaster fixation of forty-eight and eight-tenths days. The end results are highly satisfactory.

LaFerte and Nutter [5] have used the hanging plaster cast in 177 consecutive cases of fracture of the humerus. They consider this method of treatment suitable for all fractures of the humerus except those involving the condyles of the humerus or the supracondylar area of the humerus, comminuted fractures of the head and the neck with displacement and fractures of the greater tuberosity. They point out that lateral angulation can be corrected by a pad on the inner side of the elbow, medial angulation, by a sponge rubber pad in the axilla, and forward and backward angulation, by changing the height of the sling. They report no cases of delayed union or of nonunion. The average period spent in the cast was six weeks. [ED. NOTE: This method of treat-

4. Griswold, R. A.; Hucherson, D. C., and Strode, E. C.: Fractures of Humerus Treated with Hanging Cast, South. M. J. **34**:777-778 (July) 1941.

5. LaFerte, A. D., and Nutter, P. D.: Treatment by Means of Hanging Plaster Casts in Fractures of the Humerus, Ann. Surg. **114**:919-930 (Nov.) 1941.

ment has been universally accepted for fracture of the humeral shaft and in a few instances for fracture of the surgical neck as well as of the lower extremity of this bone. The fundamental principles of immobilization of the joints above and below the site of fracture are entirely disregarded in this method.]

Wright, Koenig and Shafiroff [6] review the various methods of treatment of fractures of the head and the shaft of the humerus and introduce a further modification of the hanging cast which they have termed the "extension-traction hanging cast." The plaster is applied with the patient in the sitting or the standing position with the arm freely suspended from the shoulder. It extends from the site of the fracture down to the wrist with the elbow in extension. Early motion of the shoulder and the wrist is encouraged. It is claimed that faulty position and alinement are corrected by the method itself, although reduction without anesthesia is attempted at the time of application of the plaster. Twenty-two cases are reported, and in 90 per cent of these abduction was completely restored within two months after fracture. Absence of pain was a constant feature in every case. [ED. NOTE: The high percentage of good end results obtained by the authors further substantiates the efficacy of this popular method of treating fractures of this type. This modification seems particularly desirable for fractures of the neck of the humerus and the upper third of the shaft but not for fractures in the middle and lower thirds. The average age period of the patients treated is not given, but it is assumed that they were a group of young vigorous servicemen.]

In a discussion of 35 cases of fracture of the humerus, Eve and Daniel [7] emphasize the merits of the Gurd type of spica cast for the shoulder. The authors compare the Gurd cast with the simpler hanging cast and state that they favor the former. They used local anesthesia in reducing most of the fractures. There were no nonunions, and in all cases good functional results were obtained. [ED. NOTE: Gurd [8] has developed a special axillary pad to support the arm over which a molded plaster cast is applied. This produces excellent results as the series of Eve and Daniel indicates. Recent experience with the less cumbersome hanging cast has convinced many orthopedic surgeons of its efficiency and comfort. Either method is less strenuous for the patient than the usual abduction splints and casts.]

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6. Wright, A. M.; Koenig, G. A., and Shafiroff, B.: Extension Hanging Cast for Fractures of Humerus, Mil. Surgeon **88**:542-545 (May) 1941.

7. Eve, D., and Daniel, R. A., Jr.: Treatment of Fractures of Shaft of Humerus, South. M. J. **34**:311-315 (March) 1941.

8. Gurd, F. B.: Simple Effective Method of Treatment of Fractures of Upper Two-Thirds of Humerus, Am. J. Surg. **47**:443-453 (Feb.) 1940.

Fractures of the Elbow.—Shorbe [9] has collected 32 cases of traffic elbow (car door arm or sideswipe elbow), or injury caused by riding with the elbow resting on the window of a car. He points out the extreme comminution occuring in the humerus, the radius, the ulna or all three. In analyzing the end results he notes that in 8, or 25 per cent, of 32 cases an entirely useless arm resulted.

Wood [10] reports that approximately 6 patients with this condition are treated each year at the Louisville City Hospital, Louisville, Ky. An estimated 50 per cent of these require amputation, and the others show variable degrees of permanent deformity or dysfunction. The writer emphasizes that this severe crippling injury is easily avoidable and should never occur.

Trynin [11] reports the use of a carpenter's clamp in a case of intercondylar T-shaped fracture of the lower end of the humerus with marked displacement of the fragments. The elbow was manipulated under local anesthesia, and the point was placed in acute flexion. Check-up roentgenograms disclosed that the metaphysial portion of the lower fragment was displaced medially on the shaft. To correct this a carpenter's clamp was applied over felt pads at the region of the epicondyles, and by gradually tightening this the fragments were slowly approximated. After several days roentgen examination disclosed almost complete apposition of the fragments. This was maintained by leaving the clamp in place for four weeks. Five months after the injury extension to 170 degrees and flexion to 45 degrees were possible. Roentgen examination at that time disclosed firm union with good alinement of the fragments.

O'Ferrall [12] discusses the various types of fracture of the radial head. He indicates that he prefers conservative treatment of impacted fractures of the head or fractures without displacement. He emphasizes, however, that it is important that immobilization should be carried out in the position of flexion of the elbow and supination of the forearm and that this position should be protected for three or four weeks. For the more severe types he recommends open operation. If there is a small fragment broken loose, it can be removed, leaving the remainder of the head. In the treatment of other types all the fragments can be removed; the neck can be carefully rounded off, and the orbicular ligament can be repaired. He stresses the importance of complete

9. Shorbe, H. B.: Car Window Elbows, South. M. J. **34**:372-376 (April) 1941.

10. Wood, C. F.: Traffic Elbow, Kentucky M. J. **39**:78-81 (Feb.) 1941.

11. Trynin, A. H.: Intercondylar T Fracture of Elbow, J. Bone & Joint Surg. **23**:709-711 (July) 1941.

12. O'Ferrall, J. T.: Fractures of the Head of the Radius, New Orleans M. & S. J. **93**:367-370 (Jan.) 1941.

hemostasis before closure. He recommends again the same position of flexion and supination. In any case he feels that early physical therapy is important; however, there should be careful avoidance of forced passive motion.

Fractures of Both Bones of the Forearm.—Thorndike and Dimmler [13] report 364 cases of fractures of the radius and ulna in children. In 200 of the cases the fracture was in the distal third of the forearm; in 58 it was in the proximal third, and in 106 it included the head of the radius and the olecranon process. The authors note that growth abnormalities are caused by disturbance of the proliferating cells of the cartilaginous plate and that epiphysial separation does not necessarily injure these cells or interfere with their function. For this reason growth disturbance is not common following ordinary epiphysial separation. In 50 per cent of the cases the fracture of the distal part of the forearm was of the greenstick type; in these cases closed reduction with a molded short arm cast or a sugar tong splint was done. The authors mention that long arm splints or casts should be used for fractures in the upper third of the forearm. In considering fractures of the radial head, they recommend closed reduction and fixation in acute flexion with adhesive tape and open reduction only if complication arises. The incidence of open reduction was remarkably low, being 1 per cent in cases of fracture of the distal third of the forearm, 0 per cent in cases of fracture of the proximal third of the forearm and 6 per cent in fractures of the elbow.

In recent years at the Orthopedic Hospital in Copenhagen, Denmark, Sorensen [14] has used with success a method of traction with a water pail for reduction and immobilization of fractures of the forearm. The fracture is anesthetized with local anesthetic. The hand is painted with mastisol (a solution of mastic in benzene) and fixed by adhesive tape around the fingers to two metal plates; these are screwed to a perforated cross bar, which is hung on a pulley above the head of the patient. The traction is exerted downward by a water pail hung on a sling above and close to the elbow. The upper arm is placed in 90 degrees of abduction; the elbow is placed at 90 degrees of flexion, and the forearm and the hand are placed perpendicular, midway between pronation and supination. By gradually filling the pail with water, the traction can then be regulated and eventually is combined with manual reduction until palpation and roentgenograms show that the fracture is reduced. A plaster cast is then applied. The traction is gradually reduced, and the apparatus is

13. Thorndike, A., Jr., and Dimmler, C. L., Jr.: Fractures of Forearm and Elbow in Children: Analysis of Three Hundred and Sixty-Four Consecutive Cases, New England J. Med. **225**:475-480 (Sept. 25) 1941.

14. Sorensen, F.: The Water Pail Traction Method in Reposition and Bandaging of Forearm Fractures, Ugesk. f. læger **103**:269-270 (Feb. 27) 1941.

unmounted. Even severe overriding can be corrected. Reduction and immobilization can thus be accomplished at one time. [ED. NOTE: This method was previously described by Phillippides [15] in 1937.]

Colles Fracture.—Hanflig [16] describes a rather ingenious apparatus with which to maintain the reduction of a Colles fracture while the cast is being applied. The apparatus is not for reduction of the fracture. Essentially it consists of a central post with a rest on which the palmar surface of the wrist is supported and an appliance through which traction can be applied to the fingers with Japanese finger traps. Proper adjustment can be made to fit any degree of flexion or ulnar deviation deemed advisable. Hanflig also states that with this apparatus the anesthetic time can be shortened since the anesthetic can be stopped when the arm is first placed in the apparatus. The apparatus likewise obviates the need of assistance. [ED. NOTE: It appears that this apparatus answers the purpose for which it was fashioned, but the necessity of it is questionable. From the cuts presented it seems that the cast must be applied with the elbow in complete extension and the forearm in complete supination.]

Fractures and Dislocations of the Carpus and the Hand.—Schafer [17] reports a case of bilateral semilunar luxation with simultaneous unilateral fracture of the scaphoid bone as proved by roentgen examination. The patient was a vaudeville artist 31 years of age and a member of a bicycle performing act. He had fallen from a platform 5 meters high when one of the wires holding the platform broke while he was in the act of standing on his hands, and he was thrown to the floor. The luxations were easily reduced by hyperextension of the wrists. But while this was being done, slight torsion of the left scaphoid proximal fragment occurred. Fixation was in plaster casts. After a few days the patient complained of severe pain in the left hand, and an attempt was made while he was under anesthesia to improve the position of the displaced scaphoid fragment. Reduction was not possible. On the contrary, the displacement was exaggerated. After three weeks the plaster cast was removed from the right hand, and after-treatment was begun. After the cast was removed from the left hand, it was found that not the slightest movement was possible in the wrist. For this reason the scaphoid fragment was surgically removed under local anesthesia. The wrist was then movable. Fixation was accomplished in plaster. Three

15. Phillippides, D.: Reduction of Fractures by Traction, Chirurg. **9**:409-418 (June 1) 1937.

16. Hanflig, S. S.: Apparatus to Facilitate Treatment of Colles' Fractures, Am. J. Surg. **52**:386-389 (May) 1941.

17. Schafer, A.: Bilateral Perilunar Luxation with Simultaneous Unilateral Fracture of Scaphoid Bone, Arch. f. orthop. u. Unfall-Chir. **40**:405-411, 1940.

weeks later the plaster cast was removed also from the left hand. After careful exercises the patient was able to resume the pursuance of his vocation. It is emphasized that the good results in this case were no doubt aided by the fact that the man was young, that he knew he could expect no compensation and, finally, that he was possessed of most unusual will power.

Cave [18] analyzes the cases of fracture at the Massachusetts General Hospital, Boston, and determines that retrolunar dislocation of the capitate bone with fracture or subluxation of the navicular bone was the third most common carpal injury in these cases. He ascribes the mechanism of the fracture and the dislocation to forced dorsiflexion of the wrist, usually caused by a fall on the outstretched hand. This results in a forcible tearing between the lunate and capitate bones with a dorsal dislocation of the capitate bone, the lunate bone maintaining its normal relation to the radius. The same force must either dislocate or fracture the navicular bone. Cave points out the importance of distinguishing accurately between this condition and simple dislocation of the lunate bone, the important point being the maintenance of normal relation between the lunate bone and the radius, while the capitate bone is displaced dorsally and the navicular is rotated or fractured. He indicates that the proper treatment in any case is early manipulation and that if it is carried out early enough it may be successful. If there is a fracture of the navicular bone and if the fragments are not accurately replaced by the closed reduction, open operation should be done and a dowel graft placed between the fragments at once, without waiting to determine whether or not union will occur. In cases in which closed manipulation does not satisfactorily reduce the dislocation, open operation becomes necessary, and it in itself may fail. The author emphasizes the importance in open operation of two separate incisions to expose the capitate and navicular bones. The dorsal incision is for the purpose of exposing the capitate bone and reducing the dislocation, and a curved radial incision is for the purpose of exposing the navicular bone to carry out the reposition and the dowel grafting. If closed manipulation and open operation both fail to restore anatomic position, further operation is indicated, leaving two procedures, namely, removal of both the lunate and the navicular bones or wrist fusion. Cave discusses briefly the ultimate value of these two procedures. There are several excellent case reports with excellent roentgen and anatomic drawings. [ED. NOTE: This is a good article with an accurate description and a clear recommendation as to treatment.]

18. Cave, E. F.: Retrolunar Dislocation of Capitate with Fracture or Subluxation of Navicular Bone, J. Bone & Joint Surg. **23**:830-840 (Oct.) 1941.

Soto-Hall and Haldeman[19] review the cases of 50 patients with various types of fractures of the carpal scaphoid bone and evaluate the various operative measures which have been employed in the treatment of nonunion.

The preponderance of male patients (47 to 3) indicates that the lesion is essentially an industrial injury. The majority of cases occur in the third and fourth decades of life. The high incidence of fractures to the waist of the bone and the high percentage seen early allow the writers to stress a conservative and uniform plan of treatment. The most frequent associated injury was dislocation of the lunate bone; it was present in 6 of the 50 cases, while fractures of the lower end of the radius occurred in 3.

Success of treatment depends on the recognition of the fracture within two or three weeks of the injury and on adequate and prolonged immobilization. Treatment of the various types should be considered. These types include: (1) lesions of the body through the waist; (2) lesions through the proximal pole; (3) lesions of the tubercle, and (4) comminuted fractures. In types 1 and 2 immobilization should consist of a plaster cast holding the wrist in full radial flexion and 30 degrees dorsiflexion, including the thumb, which is held in full abduction and extension. The abduction of the thumb should be maintained by pressure on its base rather than on its tip because of the possibility of subluxation of the metacarpophalangeal joint of this digit. Immobilization of the wrist is continued for ten to twelve weeks, depending on the roentgen appearance. A reenforced leather wristlet support may then be used for more prolonged immobilization. Fractures of the tubercle usually heal in from four to six weeks, and the thumb need not be included. In cases of comminuted fractures excision of the fragments should be done early, if there is indication for it, to avoid arthritic changes.

In cases of nonunion the operation of drilling recommended by Schnek has limited value and should be combined with excision of the interposed fibrous tissue and the insertion of a bone graft peg from the lower end of the radius. This additional procedure definitely improves the chances of union. Evidence of aseptic necrosis of the proximal fragment does not necessarily indicate that excision should be performed, for the authors have seen revascularization and osseous union of such a fragment following bone grafting.

Analysis of end results in 21 cases of recent fractures treated conservatively showed osseous unions in 20. In 4 cases of old ununited fractures treated conservatively there were no unions. Among 10

19. Soto-Hall, R., and Haldeman, K. O.: Conservative and Operative Treatment of Fractures of the Carpal Scapoid, J. Bone & Joint Surg. **23**:841-850 (Oct.) 1941.

cases in which drilling alone was done, union took place in 5. In 8 cases in which treatment consisted in combined bone grafting and drilling, osseous union occurred in 6. Of the 50 patients, 36 returned to their former type of work.

Pathologic study of 5 excised navicular bones showed a characteristic fusiform area of absorption occurring along the line of fracture which was replaced by fibrous connective tissue. Near the center of the fracture this gives an appearance of cystic degeneration, although a true cyst does not occur. Microscopic studies of the articulating cartilage show the inability of hyaline cartilage to regenerate, the defect being filled in with connective tissue which may take on some of the characteristics of fibrocartilage.

Lamb,[20] in a detailed discussion of fractures of the fingers, stresses the accompanying injury to the tendons and the tendon sheaths with the usual result of permanent disability. He states also that in compensation estimates the value of fingers is definitely underrated. The usual estimates provide for no adequate remuneration to the person for the loss of the use of a digit. In many instances in which poor results are obtained, the person would prefer to have the finger amputated to having the disability of a stiff finger.

The surgical anatomy of the fingers, the classification of the various fractures and the methods of reduction are covered in an elementary manner, beginning with fractures of the proximal phalanx, which are more liable to angulate and override than those of the middle phalanx, and ending with those of the spongy portion of the distal phalanx. There is always the possibility of partial or complete severance of tendons in compound fractures.

The various methods of reduction and immobilization presented are standard types, varying from the use of a simple palmar ball or roller bandage in the curve of the fingers to the use of the banjo splint, which is particularly applicable to multiple fractures. Lamb stresses the importance of prevention of pressure necrosis caused by improperly applied splints.

In postoperative care early active motion with light massage is recommended. Too much importance cannot be placed on massage and the wholehearted cooperation of the patient in regaining function.

Kaplan [21] gives an excellent review of the diagnosis, the prognosis and the treatment of fractures of the hand. He emphasizes particularly the fact that long immobilization tends to lead to diminished circulation,

20. Lamb, E. D.: Fractures of the Fingers, Journal-Lancet **61**:372-374 (Sept.) 1941.

21. Kaplan, L.: Treatment of Fractures and Dislocations of Hand and Fingers: Technic of Unpadded Casts for Carpal, Metacarpal and Phalangeal Fractures, S. Clin. North America **20**:1695-1720 (Dec.) 1940.

muscle and bone atrophy and stiff joints. Active motion should be instituted early, provided proper immobilization can be maintained. For fractures of the navicular bone, he uses an unpadded plaster cast which extends from the elbow to the middle of the hand and out to the last joint of the thumb. If union does not result after several months, drilling may be employed. In cases of dislocation of the entire carpus, he emphasizes the importance of the accompanying fracture of the radius and the ulna, which usually occurs at the articular surface, and recommends the use of an unpadded cast with mobilization after six weeks. In discussing Bennett's fracture, he advises waiting three to four days before manipulation is carried out, and if the position cannot be readily held, he suggests fixed wire traction through an unpadded cast. In treating fractures of metacarpals with displacement, he again recommends waiting a few days before manipulation is carried out. He notes that it is particularly important in treating phalanges that adequate motion be permitted in the uninvolved portions of the finger and in the uninvolved fingers in order to prevent residual stiffness. [ED. NOTE: Too little attention is given to the proper care of fractures of the bones of the fingers, the hand and the wrist. The days lost from work from such injuries is too high. More attention should be directed to such disabilities.]

Spotoft [22] states that as ordinarily practiced pulp extension for fractures of the fingers has several disadvantages which can be eliminated by the use of a cannula. A suitable cannula is inserted through the pulp at the usual site, and the tip of the cannula is broken off. A fine metal wire is then drawn through the cannula, and the rest of the procedure is as usual. The cannula should be short, heavy and polished. An ordinary WR cannula is sufficient. The tip of the cannula should be toward the side on which it will not interfere with the other fingers (or toes). Small pledgets of gauze soaked in mastisol are placed over the puncture wounds on both sides of the pulp to prevent infection. Extension by this method is painless, even with considerable traction. The cannula does not cut into the pulp like a wire does, and infection of the puncture canal is thus prevented. If the wire breaks, another can easily be inserted.

Fractures of the Head and the Neck of the Femur.—A thorough study of the problem of fractures of the hip has been made by the Fracture Committee of the American Academy of Orthopaedic Surgeons.[23] It is based on a careful analysis of 1,485 cases submitted by

22. Spotoft, J.: Cannula Extension for Fractures of the Fingers, Ugesk. f. læger **102**:627-628 (June 13) 1940.

23. Treatment of Fractures of Neck of Femur by Internal Fixation, Report of Fracture Committee of American Academy of Orthopaedic Surgeons, J. Bone & Joint Surg. **23**:386-390 (April) 1941.

a large number of surgeons. Rigid requirements as to site of fracture, evidence of displacement, reduction and follow-up observation preclude the possibility of confusion with simpler intertrochanteric or impacted fractures.

Of 241 cases analyzed in detail, union was found to occur in 70.1 per cent. There was a mortality rate in the entire series of 11.6 per cent. Severe arthritic changes in the hip joint occurred in 14 per cent.

[ED. NOTE: The committee is continuing its work and will study the late effects of internal fixation on the fracture of the head of the femur and the hip joint. Its opinions are based on the most severe requirements. This report is of immense scientific value.]

Boyd [24] reviews 150 fractures in the neck of the femur treated at the Willis C. Campbell Clinic, Memphis, Tenn., and sets forth general rules of treatment. With improved technic and local anesthesia when necessary almost any patient with such a fracture can be operated on, and a flanged nail can be inserted. Operations are performed as soon as possible to prevent discomfort and unfavorable complications. A flanged nail can be placed under roentgen guidance with a minimum of shock. After operation the patient is moved about freely in bed and wheel chair. No weight bearing is allowed for several months. Seventy-five per cent of the patients were female; more than one third of them were in the seventh decade of life. There was a mortality rate of 10.2 per cent and in 86 per cent of those patients that could be followed bony union was obtained. [ED. NOTE: The author's salient observations on early operation and freedom from weight bearing after operation are most important. Many failures in the early days of hip nailing resulted from allowing patients to bear weight too early. It was overlooked that the cancellous atrophic bone in the femoral head provided only nominal grasp on the nail in spite of the roentgen appearance of rigidity. We feel that the patient should be allowed out of bed early in a wheel chair but that no weight bearing should be permitted for several months. One main advantage of doing open reduction and internal fixation of the hip, especially in treating aged patients, is that the patient can be allowed out of bed, and this prevents serious complications, especially pneumonia.]

Geckeler and Tuttle [25] report the use of parallel metal screws (Martin method) in 50 cases of fracture of the neck of the femur since October 1936. Fractures are reduced, and the position is checked by fluoroscopic examination. Guides and drills also are placed with the use of the fluoroscope.

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24. Boyd, H. B.: Treatment of Acute Fractures of the Neck of the Femur, South. Surgeon **10**:364-371 (May) 1941.

25. Geckeler, E. O., and Tuttle, A.: Fractures in Neck of Femur, Accurate Subcutaneous Fixation with Screws, Surg., Gynec. & Obst. **72**:106-111 (Jan.) 1941.

The authors use steel screws, which they state do not result in bone absorption owing to the tightness with which they are fixed in the bone.

[Ed. Note: The illustrations show good placing of the screws and excellent reductions. This probably is the explanation of the tightness of the fixation and the reason why there is little absorption of bone. With good reduction and adequate fixation most of the common unfavorable complications are eliminated. Much aseptic necrosis or extrusion of the nail is due to poor reduction at first and inadequate fixation. These complications are becoming less frequent as surgeons are devising better ways to reduce and anchor these fractures.]

After a discussion of the hip joint from the anatomic and the physiologic points of view, Engel [26] presents his methods of treating various types of fracture in this joint.

For some irreducible central dislocations of the head of the femur he uses a rather formidable operation in which the medial side of the acetabulum is exposed and is forced back into its normal position.

For treatment of fractures in the neck of the femur he describes the technic of blind nailing with the aid of the well known Engel-May direction finder. The same technic is used in treating some intertrochanteric fractures in which the trochanteric fragment is large enough to hold a Smith-Petersen nail without splitting.

[Ed. Note: Exception may be taken to the observation that the Smith-Petersen nail becomes surrounded by a "fibro-cartilaginous membrane" which "seems to give off blood vessels" into the head and the neck of the femur. Could this not be fibrosis about the nail caused by electrolytic irritation from the metal in the nail?]

Eyre-Brook and Pridie [27] report 75 consecutive cases of intracapsular fractures of the femur in which a Smith-Petersen nail was used. In the presentation of their series of cases there is a rather interesting analysis of end results: In 58 per cent bony union was obtained; in 13 per cent fibrous union; in 10 per cent doubtful union; in 8 per cent the pinning failed; in 6 per cent necrosis of the femoral head developed, and in 4 per cent there was infection with resultant nonunion. In analyzing the cases of necrosis of the femoral head, the authors bring out the point that there was a remarkably higher percentage of necrosis in the younger age groups. The age distribution was as follows: under 30 years, 60 per cent; between 30 and 60 years, 16 per cent, and between 60 and 90 years, 12 per cent. The authors point out that this is of considerable significance from the standpoint of prognosis. The mortality rate in this series was 5.3 per cent.

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26. Engel, G. C.: Fractures About the Hip, S. Clin. North America **20**:1721-1741 (Dec.) 1940.

27. Eyre-Brook, A. L., and Pridie, K. H.: Intracapsular Fractures of Neck of Femur: Final Results of Seventy-Five Consecutive Cases Treated by Closed Method of Pinning, Brit. J. Surg. **29**:115-138 (July) 1941.

Sandner and Thompson [28] list the different varieties of fractures of the femoral neck and discuss the anatomic features of the region in question and the changes occurring in old age which lead to the prevalence of this fracture.

The mechanism causing this fracture is discussed in considerable detail. The force causing the injury may act in at least one of three primary directions. When the force acts in the lateromedial direction, as in a fall on the greater trochanter, the compression element tends to produce an impacted fracture of the neck or a central dislocation of the head of the femur. When the force acts in an anteroposterior direction resulting in a rotation mechanism, various types of fractures of the femoral neck occur. With the force acting vertically from above downward directly on the head of the femur, as the force caused by a misstep, the shearing mechanism is the major factor with a decrease of the neck-shaft angle to less than 135 degrees.

[ED. NOTE: The authors discuss and consider at length the mechanical aspects of this fracture, the details of which have been painstakingly worked out.]

Wise [29] gives a detailed description of the gross pathologic and the histologic study of a specimen in which a transcervical fracture of the femur occurred thirteen months before death. A vitallium Smith-Petersen nail was used to transfix the fragments. Grossly, there was evidence of solid bony union with the fracture site faintly visible. The articulating cartilage of the head and the ligamentous attachments of the greater and lesser trochanters were dark brown. This was thought to be due to degeneration, although the cartilage was smooth, normal in thickness and well preserved. By special stain this pigment was found to be iron.

The outstanding feature was the glistening smooth surface of gray membrane which lined the nail tract throughout its entire course. Microscopic study of this lining showed it to consist of two well defined layers, viz., an inner layer of connective tissue and an outer layer of bone trabeculae. Numerous blood vessels were present in the outer section of the connective tissue layer in addition to groups of small deeply stained pigmented granules of iron. These pigment granules are known as rust granulomas. Since in this instance a vitallium nail, in which there is no iron, was used, they were considered to be derived from broken-down red blood cells. The new blood vessels in the connective tissue of the nail tract apparently increase the blood supply across the fracture site with better nutrition of the head. Massive bone

28. Sandner, E., and Thompson, E. C.: Causation of Fractures of Neck of Femur, M. J. Australia **2**:383-391 (Oct. 4) 1941.

29. Wise, R. A.: Histologic Study of Transcervical Fracture of Femur after Internal Fixation, J. Bone & Joint Surg. **23**:941-947 (Oct.) 1941.

lamellas along the nail tract indicate that this alloy does not prevent bone formation. The tract made by the nail produces a fibrous tissue cavity not unlike a bone cyst.

Radiation Fractures of the Neck of the Femur.—In a comprehensive study Strauss and McGoldrick [30] point out that the occurrence of fractures of the femoral neck as a complication of irradiation for malignant growth in the pelvis is not infrequent. Their study gives a review of the anatomic and physiologic considerations, a discussion of causes other than radiation of spontaneous fracture (e. g. nutritional defect and metastasis), a consideration of radiation therapy as it affects adult bone and a survey of reported cases. They add 4 of their own cases. This study shows conclusively that spontaneous fractures of the neck of the femur with pathologic findings at autopsy characteristic of radiation effects should have serious consideration. It must be borne in mind that the vascular supply of the femoral neck is terminal and vulnerable to postradiation vascular occlusion. Owing to the proximity of the femur to the surface the depth dose to the bone and its vascular supply is practically the same as the surface dose. This must be borne in mind in evaluating the term "relative radiation resistance." Excessive roentgen therapy, whether given in one prolonged cycle or in smaller repeated cycles, imperceptibly reaches dangerous proportions, the consequences of which become more serious with the lapse of time. In addition, these patients at the onset are poorly nourished owing to calcium-phosphorus imbalance and therefore are more susceptible to fractures. [ED. NOTE: The authors' suggestion relative to the prevention of this disabling complication by giving greater protection to this vulnerable area is most appropriate and should be followed by roentgenologists.]

Hight [31] reports a spontaneous fracture of the femoral neck of a man 58 years of age following roentgen therapy for a malignant growth of the penis with involvement of the inguinal glands.

A review of 1,084 cases with primary malignant growth in the region of the pelvis treated by roentgen therapy in the Pondville Hospital at Norfolk, Wrentham, Mass., discloses only 1 case of this type, giving an incidence of 0.09 per cent. This occurred without any evidence of metastasis to the neck or the head of the femur, but there was contributing arteriosclerosis. In other clinics the average incidence has been approximately 2.5 per cent.

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30. Strauss, H., and McGoldrick, J. L.: Fractures of Femoral Neck Following Roentgen Therapy for Gynecologic Malignancy, Am. J. Obst. & Gynec. **41**:915-934 (June) 1941.

31. Hight, D.: Spontaneous Fracture of Neck of Femur Following Roentgen Ray Therapy over Pelvis, J. Bone & Joint Surg. **23**:676-681 (July) 1941.

It is emphasized that in giving roentgen therapy over the pelvis, the portals should be so placed as not to include the region of the femoral necks.

Baker [32] gives a report of a case in which a fracture appeared gradually in the neck of the femur following roentgen therapy for uterine carcinoma. [ED. NOTE: The development of the deformity in this case resembled the changes seen in cases of slipped femoral epiphysis. Since there was no evidence of skeletal metastasis as the cause of the fracture, it appears that radiation osteitis was the cause. Perhaps roentgen therapy to pelvic viscera produces marked alterations in the blood supply of the adjacent tissues with ischemia of the neck of the femur.]

Fracture-Dislocations of the Hip.—King and Richards [33] review the history and the mechanism of injury in fracture-dislocations of the hip, which are characteristically an automobile injury. Their study includes experimental lesions of this type in a series of 8 dogs and a report of 7 clinical cases. The experimental work demonstrates that rapid disintegration occurs in the hip joint following incomplete reduction; in each case a severe degree of degenerative arthritis developed within a few weeks.

The three common varieties are: (1) fracture of the posterior lip of the acetabulum; (2) sprain fracture of the femoral head, in which a small fragment of the head attached to the round ligament remains in the acetabulum, and (3) transverse fracture across the floor of the acetabulum.

The indications for open reduction are: (1) largeness of the lip fragment of the acetabulum and failure to return to normal position when the head is reduced; (2) presence of the lip fragment in the acetabulum; (3) impossibility of the head being perfectly reduced or a fragment of it being free in the acetabulum; (4) fracture through the floor of the acetabulum allowing rotation of the distal half of the innominate bone, and (5) associated fracture of the femoral shaft preventing control of the head.

The operative technic is described in detail, the approach consisting of an incision from the posterior iliac spine outward and downward to the base of the greater trochanter. As the two halves of the gluteus maximus muscle are retracted from each other, there is complete exposure of the sciatic nerve, the gluteus medius, the piriformis, the obturator internus and the gemelli muscles. With the sectioning of

32. Baker, L. D.: Spontaneous Fracture of Femoral Neck Following Irradiation, J. Bone & Joint Surg. **23**:354-358 (April) 1941.

33. King, D., and Richards, V.: Fracture-Dislocations of the Hip Joint, J. Bone & Joint Surg. **23**:533-551 (July) 1941.

the common tendon of the latter three muscles the posterior wall of the acetabulum is easily exposed. After the lip fragment of the acetabulum is replaced, it is held in place with one of the commonly used bone screws, which should be directed at an oblique angle upward to avoid penetrating the articulating cartilage. Immobilization for eight to ten weeks following the operation is recommended, with weight bearing at the end of twelve weeks.

A detailed case analysis is not given, although a series of roentgenograms of 3 patients in whom accurate replacement of the lip fragment was done show clear-appearing hip joints at the end of three and five years.

Roentgenograms of hips in which there was inaccurate replacement compared with those showing perfect position well illustrate the complicating arthritis demonstrated in the experimental study.

[ED. NOTE: This excellent article illustrates the importance of accurate replacement of fragments involving articulating surfaces, particularly in weight-bearing joints.]

Trochanteric Fractures of the Femur.—Lippmann [34] discusses the use of the corkscrew bolt for internal fixation of intertrochanteric fractures of the femur. He points out that with intertrochanteric fractures there is a tendency for separation of the fragments and return to a varus position following reduction. He further points out that any method of traction will prevent this but that fixation and rest in bed of long standing for elderly people carries a high mortality rate. He feels that open operation is not justified for young healthy patients, but that it is necessary for elderly people who will not stand confinement. He further states that this corkscrew causes direct traction between the head and the shaft fragment, adequately maintaining the position. He reports 3 cases in which it was used, all of them being cases of simple trochanteric fractures without comminution. [ED. NOTE: Use of this bolt seems to have the same contraindication in cases of intertrochanteric fractures as does the Smith-Petersen nail or its modifications, namely, that the results are satisfactory only if there is no comminution and there is a long intact fragment of the trochanter firmly adherent to the shaft. In the presence of comminution, internal fixation requires some method of fixation of the bolt through the shaft of the femur distal to the fracture line. For this reason we do not believe this bolt would work in the ordinary comminuted intertrochanteric fracture.]

Morris [35] discusses a group of trochanteric fractures and emphasizes again the unusually high mortality rate associated with this type of

34. Lippmann, R. K.: Role of Internal Fixation with Corkscrew Bolt in Intertrochanteric Fractures, J. Mt. Sinai Hosp. **7**:459-466 (Jan.-Feb.) 1941.

35. Morris, H. D.: Trochanteric Fractures, South. M. J. **34**:571-578 (June) 1941.

fracture in the average charity institution. He discusses the various types of internal fixation and the requirement for each, observing that he feels the best results occur with the Neufeld nail or with the Smith-Petersen nail and the Thornton plate. The latter was used in a series of 28 cases which he reports. In this series he was able to reduce the mortality rate to 21.4 per cent by internal fixation. He concludes that internal fixation "adds greatly to the comfort of the patient, reduces pain, facilitates nursing care and definitely reduces the length of hospitalization." [ED. NOTE: This article again calls attention to the fact that it is the patients who are poor operative risks who most require operative reduction, since the healthy patient will usually recover by almost any recognized method of treatment.]

Fractures of the Shaft of the Femur.—Lewis [36] gives a report of the treatment of 156 fractures of the femur with Russell or balanced traction. He describes an unfortunate experience with skeletal traction in which infection of the bone occurred around the knee, and he is apparently convinced that this is an unsatisfactory method for treatment of fractures of the femur. The mortality rate was only 3.2 per cent, although the average age in this series was 58 years. The average days of hospitalization were one hundred. The author reports 7 cases, or about 3.5 per cent, in which reduction could not be obtained. In 5 of these open reduction with internal fixation was done, and satisfactory results were obtained. He tabulates the results obtained in those patients treated throughout by Russell traction; he had 100 per cent good results in those with shaft fractures and over 90 per cent good results in those with intertrochanteric fractures. The figure for patients with shaft fractures does not include the 7 cases which the results were unsatisfactory; in these Russell traction had been discontinued. The author stresses the importance of close attention to the detail of application of Russell traction apparatus. [ED. NOTE: This author presents an enthusiastic argument for the use of Russell traction. His series of cases shows results far superior to those reported by other writers using similar methods of treatment. He reports no delayed union and no nonunion in this series of 71 fractures of the shaft. The mortality rate for the series of 3.2 per cent, including a large number of old people, is remarkably low. The author's condemnation of skeletal traction appears to be based largely on the use of tongs and Steinmann pins, although he does mention Kirschner wires; apparently skeletal traction was used in conjunction with a Thomas splint with a Pierson attachment. He condemns the position used in a Thomas splint. Altogether

36. Lewis, K. M.: Russell Traction in Treatment of Fracture of Femur: Observation on One Hundred and Fifty-Six Cases, Ann. Surg. **113**:226-244 (Feb.) 1941.

the report seems somewhat biased and based on an extremely unfortunate experience with the use of skeletal traction.]

Swart [37] reports 6 cases of fractures of the femoral shaft in which he used two wire traction for control of the distal fragment. In 5 of the cases described there was anterior displacement of the distal fragment following the application of the Kirschner wire through the condyles with traction. This was overcome by the insertion of a second wire through the proximal end of the distal fragment and traction made in a downward direction. The same principle may be used when the distal fragment remains posterior with the traction then on the second wire in the upward direction. In the cases in which the fractures were treated by this two wire traction method the results were good. [ED. NOTE: This simple method affords good control of the distal fragment in fractures of the shaft of the femur, and this control may be utilized with distinct advantage.]

Cubbins,[38] in a detailed article, covers the treatment of fractures of the shaft of the femur from the technic of the simple fundamental principles of skin traction, the use of which he advocates in the majority of cases, to a brief discussion of delayed union and nonunion. If skeletal traction must be used, a Steinmann pin is advocated rather than the Kirschner wire, and this is to be placed through the upper end of the tibia rather than through the lower part of the femur. The author contends that a Kirschner wire may cut from ½ to ¾ inch (1.3 to 1.9 cm.) down through the condyles of the femur. This combined with the fact that there is a tendency of the wires to slide back and forth through the bone makes it more dangerous and uncomfortable than the the larger pin. The operative attack is reserved for those fractures in which interposition of soft tissue is evident as well as for condylar fractures of the lower end. [ED. NOTE: If the author accomplishes nothing else, he at least has stressed emphatically the conservative handling of these types of fractures. When skeletal traction is necessary, the Kirschner wire has been universally accepted because of the smaller caliber of the penetrating wound which results in less tissue destruction and makes the possibility of infection more remote. We seldom have had the complications with the Kirschner wire which the author outlines.]

Fractures of the Patella.—For fractures of the patella Dickson [39] describes an operative procedure utilizing a V-shaped strip of the

37. Swart, H. A.: Treatment of Fractures of Shaft of Femur by Double Wire Traction, Am. J. Surg. **52**:507-510 (June) 1941.

38. Cubbins, W. R.: Treatment of Fractures of Shaft of Femur, Tr. West. S. A. (1940) **50**:106-124, 1941.

39. Dickson, J. A.: Treatment of Fracture of the Patella, Cleveland Clin. Quart. **8**:154-157 (July) 1941.

quadriceps tendon which is left attached at its lower end and is of sufficient length to reach the tibial tubercle. After removal of the comminuted fragment of the fractured patella, this strip is fixed firmly to the previously reflected portion of the patellar tendon and the periosteum on the anterior surface of the patella. The transplanted portion of tendon aids in filling in the defect caused by removal of the fragments and reenforces the patellar tendon so that quadriceps exercises may be instituted in ten days and all protective dressing may be removed at the end of the third week. In the course of six weeks flexion to 90 degrees is to be anticipated. [ED. NOTE: This method is particularly indicated for the comminuted fractures, especially those in the lower pole of the patella, where excision of the small fragment and the retention of the major portion of the upper half are possible.]

Prince [40] reports a series of 14 cases of fractures of the patella in which partial excision of the bone was carried out with satisfactory results. The operative technic is similar to that uniformly used, namely, removal of the lower fragment or fragments and exposure of the upper fragment, which is securely sutured to the patellar tendon by mattress sutures of no. 2 or no. 3 chromic catgut. To obtain firm fixation of the patella three drill holes are made through its lower margin, extending downward and forward; through these the fixation sutures are threaded. Following careful repair of the fibrotendinous layer over the patella and the lateral portions of the capsule and the aponeurosis, the limb is immobilized in a light cast for two to three weeks. The patient is allowed to walk in ten days and permitted joint motions in the third week.

In a discussion of the various methods of treatment of this fracture the writer states that complete excision of the patella as advocated by some is too radical a procedure, although for the severely compound comminuted type this may be advisable. In 1 of his patients a good result with full extension and flexion to 90 degrees was obtained when the compounded upper fragment was removed and the quadriceps tendon was sutured to the distal fragment. He mentions also the value of this method in cases of malunion or nonunion of the patella, in which painful symptoms persist. [ED. NOTE: We heartily agree with the author in advising against complete removal of the patella when fractured.]

Fractures of the Condyles of the Tibia.—Buckner [41] states that fractures of the upper end of the tibia often result in poor function

40. Prince, L. D.: Treatment of Fractures of the Patella by Partial Excision of Fragments, Am. J. Surg. **53**:232-236 (Aug.) 1941.

41. Buckner, H. T.: Fractures of Upper End of Tibia with Lateral Displacements, Am. J. Surg. **51**:707-721 (March) 1941.

because of damage to the ligaments of the knee and inadequate reduction. It is important for good function to restore the joint surface to as near to normal as possible. The author achieves this by drilling a hole across the upper end of the tibia and passing a wire through the fragments. The wire is threaded through a metal button on each side and is then twisted tight. The roentgenograms presented in this article reveal excellent replacement of the fragments. At the end of three weeks patients are allowed to begin weight bearing with a Thomas splint. [ED. NOTE: Bolts, nails and screws have been used for years in treating these fractures. The method of fixation with wire threaded through buttons may provide more secure reduction and fixation. At least it does in the hands of the author. The principal criticism of the method is the dependence on a twisted strand of wire for the whole support. Emphasis should be placed also on the importance of not allowing too early weight bearing in these cases.]

Wise [42] recommends combined traction and compression for bicondylar fractures of the tibia by the use of Kirschner wire traction through the os calcis and the compression by a sleeved wire [43] inserted through the tibial condyles. The point of insertion of the compression wire will vary, depending on the types of displacement and the level of the fracture. By gradual tightening of the nut on the other end of the wire the condyles are forced together.

If the sleeved wire is properly placed, compression of one or both condyles apparently is easily accomplished when adequate longitudinal traction through the os calcis is used. The compression sleeve used consists of three parts: (1) a Kirschner wire of medium diameter to which is welded a fixed metal bead and washer; (2) a metal sleeve which slips over the wire, and (3) a threaded collar with a setscrew and nut.

A case report illustrating the method shows anatomic reduction with a satisfactory functional end result.

The author suggests the use of this method of fixation for badly displaced fractures of this type, for which arthrotomy and open reduction are necessary.

Dobelle [44] reviews the various methods of treatment of fractures of the external condyle of the tibia, stresses the conservative method of handling this injury and describes a simple method which he has used in 5 cases with successful results.

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42. Wise, R. A.: Combined Traction-Compression Method for Treatment of Bicondylar Fractures of the Tibia, Surg., Gynec. & Obst. **72**:778-780 (April) 1941.

43. The sleeved wire can be obtained from the De Puy Manufacturing Company, Warsaw, Ind.

44. Dobelle, M.: New Method of Closed Reduction of Fracture of Lateral Condyle of Tibia, Am. J. Surg. **53**:460-462 (Sept.) 1941.

The technic consists first of all of the application of a foot, leg and thigh cast with the leg in complete extension. Particular attention is paid to padding the outer upper aspect of the thigh and the medial aspect of the knee. In the cast are incorporated a pair of ordinary hinges, one anteriorly and the other posteriorly, eccentrically placed at an angle of about 30 degrees with a convexity mesialward and with apexes centered over the knee joint proper. Elliptic sections of the plaster are removed on each side of the hinges, and the leg is gradually brought into as much varus as desired. A wooden block is then inserted as a strut against the lateral cuts of the cast edges at the posterolateral aspect. In addition, molding of the comminuted mass is done by blows with a rubber mallet, and then lateral compression is applied with a furniture clamp.

In the 5 cases absolute immobilization was carried out for ten weeks and was followed by the application of a walking caliper brace. No weight bearing was allowed for six months. The final end results were gratifying; painless freely movable joints were obtained.

Dislocations of the Knee.—Wilson, Michele and Jacobson [45] report 6 cases of complete dislocation of the knee joint without complicating fractures involving the joint occurring over a period of thirteen years. Excellent results were obtained by conservative treatment consisting of immediate manipulative reduction and plaster fixation. One patient had an exploratory operation, but no ligamentous repair was attempted. All patients were male, ranging between 15 and 35 years of age, except one, who was 63 years. Each patient had a good result with apparent spontaneous repair of the internal ligaments of the knee.

In the opinion of the writers there is no indication for repair of cruciate ligament injuries until conservative methods have failed, and they suggest at least one year of observation before attempting any of the various methods of reconstruction for cruciate ligament laceration.

[Ed. Note: This study of 6 cases of a rare injury should be carefully reviewed by all radically minded surgeons who advocate immediate operative repair. In spite of variable degrees of instability, the functional end result in cases of this type is often surprisingly good.]

Fractures of the Tibia and the Fibula.—DeGoes [46] presents a clinical study of 50 cases of fracture of the shaft of the tibia. The author rightly emphasizes the ease of early reduction compared with late reduction. He favors traction on the Braun frame followed by the use of a plaster

45. Wilson, M. J.; Michele, A. A., and Jacobson, E. W.: Complete Dislocation of Knee Joint: Report of Six Cases with End Results, Am. J. Surg. **52**:77-81 (April) 1941.

46. deGoes, H.: Technic of Treating Diaphysial Fractures of the Tibia, Rev. brasil. de cir. **10**:15-34 (Jan.) 1941.

cast and the insertion of pins above and below the fracture when necessary. His 2 delayed unions occurred when the fibula was intact, and he advises osteotomy of the fibula to permit proper traction on the tibia. [ED. NOTE: This is an excellent way to overcome the tendency to interference of union caused by the intact fibula. Wedging the cast to overcome angulation is likewise stressed, and this also is a simple means of perfecting the position of the fragments.]

Juers [47] discusses briefly the treatment of fractures of the tibia and the fibula, emphasizing the necessity of putting the cast from the groin to the toes with the knee slightly flexed. He recommends the use of a stirrup, including a windlass, to obtain traction with a Steinmann pin through the heel for comminuted or oblique fractures. This permits a certain amount of ambulatory treatment in cases in which traction is necessary. The windlass consists of a rotating bar, a key inserted in a metal stirrup; this in turn is incorporated in the cast in the lateral position.

Mansfield [48] reviews 15 cases of oblique fracture of both bones of the leg seen in 1939 at the United States Marine Hospital, Detroit. It was found that in 60 per cent of the cases sharp fragments were caught in muscle or other soft tissue and that this prevented accurate closed reduction. If the fractures were explored early and the fragments were wired in normal position, the bones healed more promptly, and the cost of treatment was less. [ED. NOTE: It is true that oblique fractures of the tibia are difficult to reduce even when the fibula also is fractured. On the other hand, when both bones are fractured, there are few cases of delayed union or nonunion of fractures of the tibia with closed methods of treatment.]

Jensen [49] had an opportunity of observing 12 fractures of the fibula from overstrain at an aviation hospital. The patients were between 18 and 20 years of age. All had been hurt while vaulting. The injury in all cases was located about a handbreadth below the head of the fibula. The patients came for treatment for pains in the leg which they themselves attributed to the muscles. In many cases the fracture was difficult to demonstrate in roentgenograms and could frequently be visualized in these only through a lens. Jensen asserts that fractures from overstrain occur frequently in hitherto normal bones, so that previous fractures can hardly be considered as the responsible factor. In 9 of the cases

47. Juers, E. H.: Fractures of Distal Half of Tibia and Fibula, Minnesota Med. **24**:172-174 (March) 1941.

48. Mansfield, R. D.: Treatment of Oblique, Spiral Fractures of Both Bones of Leg: Analysis of Fifteen Cases Treated by Open and Closed Methods, J. Bone & Joint Surg. **23**:910-916 (Oct.) 1941.

49. Jensen, W.: Fractures of Fibula Due to Overstrain, Twelve Personal Cases, Zentralbl. f. Chir. **67**:2148-2153 (Nov. 16) 1940.

presented there was more or less pronounced weakness of the connective tissue as evidenced by epigastric hernia and foot deformities. Eight of the patients had pronounced acrocyanosis; this indicates a definitely deficient circulation. Eight patients complained likewise of muscular cramps in the leg or of muscular induration. In 4 cases cramps had been present some days before the injury, and in the other muscular indurations were reported as occurring at the time of injury. The author states that there is an analogy between these fractures and those occurring in association with metrazol and insulin shock. He expresses the opinion that these muscular lesions may be considered as evidence of disturbed glycogen metabolism directly related to the vascular system which is not equal to the sudden strain and that during the course of development of muscular cramps and indurations a vicious circle is instituted. The author suggests the name "myogenic fracture" for such lesions.

Fractures and Dislocations of the Ankle.—Brothers [50] reports that with the greater enthusiasm for winter sports, a new injury (ski fracture) of the ankle has appeared. Overzealous amateurs and unskilled exhibitionists account for most of them. In this injury the point of the ski turns out, and the patient falls forward, thus producing sharp outward rotation and extension of the ankle. There is nearly always a spiral fracture of the lower end of the fibula, but the internal malleolus is not broken. The potential seriousness of the injury comes from tearing of the ligaments of the ankle joint proper. Such accidents are prevented by adequate instruction beforehand, avoidance of fatigue (most cases occur in the late afternoon) and proper consideration of the hazards of bad weather. [ED. NOTE: From the military angle this presentation is of much potential importance today.]

Selig [51] describes briefly 2 cases of disability due to unreduced dislocation of the posterior marginal fragment in fractures of the ankle. A large number of painful disabling ankles are due to this condition. Lateral displacement is usually recognized and effectively reduced and maintained, but posterior displacement is sometimes overlooked. There is little in the literature on this subject. Scudder and others have mentioned the difficulties it may produce. Cotton states that unless such dislocation is reduced it may result in serious disability in many instances. Selig discusses the technic of treatment recommended by Watson-Jones and Böhler. Not all such dislocations are difficult to reduce. They are most easily reduced if the fracture is recognized and

50. Brothers, W. W.: Ski Injuries at Sun Valley. Discussion of Causes, Unusual Type of Fracture and Treatment, Northwest Med. **40**:14-16 (Jan.) 1941.

51. Selig, S.: Posterior Marginal Fragment in Fracture of Ankle, J. Mt. Sinai Hosp. **7**:497-502 (Jan.-Feb.) 1941.

treated by proper manipulation. The correction of lateral displacement of Pott's fracture will not correct the posterior displacement.

The technic for reduction of the posterior displacement is described as follows: With the patient under anesthesia traction is exerted on the tarsus in a distal direction. When traction is maintained, the surgeon gradually changes the direction of force to a straight upward pull to the ceiling with simultaneous reduction of equinus until the foot is at right angles with the leg. If this attempt fails it should be repeated with the knee flexed to 90 degrees to relax the gastrocnemius muscle. Associated malleolar fractures must also be reduced. In applying the plaster extreme inversion of the foot must be avoided. If possible, the foot should be immobilized in a neutral position at an angle of 90 degrees to the leg. The plaster cast is applied from the toes to the midthigh with the knee at 90 degrees flexion. If the ankle is badly swollen, immobilization can be accomplished by a wire through the os calcis until the edema subsides.

The original plaster should be changed in four or five weeks to a walking cast extending to the tibial tubercle. The time for change varies with the severity of the case. After removal of the cast, a gelatin bandage or firm adhesive is applied from the toes to the tibial tubercle. Little physical therapy is needed to restore normal function to the ankle joint. If reduction has been unsatisfactory, prolonged physical therapy is required, and even with this there may still develop traumatic arthritis between the astragalus and the tibia so that fusion may become necessary.

Fractures and Dislocations of the Astragalus.—Miller and Kolb [52] report 2 cases of talonavicular dislocations and include a brief review of some 139 reported cases, indicating the various types and that the inward dislocation is the most common. In 1 of their cases reduction was easily obtained by manipulation; in the other case operation was required. They conclude that if the dislocation cannot be reduced with the patient under anesthesia after comparatively mild manipulation, it is better to wait ten days for the edema to subside and then do open reduction. In both of the cases excellent functional results were obtained. [ED. NOTE: In cases in which the patient is seen early, it is difficult to understand deliberately postponing operative reduction, unless there is some contraindication for operation, e. g. in the nature of the condition of the patient or the condition of the skin.]

McCurrich [53] reports the unusual case of complete expulsion of the astragalus in a young sailor whose ship struck an unsuspected mine.

52. Miller, L. F., and Kolb, L. H.: Talonavicular Dislocation, Am. J. Surg. **51**:439-441 (Feb.) 1941.

53. McCurrich, H. J.: Traumatic Expulsion of Astragalus, Brit. J. Surg. **28**: 611-614 (April) 1941.

The exact mechanism of injury is not known, but the patient was blown into the air, falling into the water, sustaining injury of the soft tissue in the left shoulder, which was more painful than the marked compound dislocation at the ankle.

Roentgen examination disclosed complete absence of the astragalus, with a transverse fracture of the external malleolus. The compound injury was over the medial aspect of the ankle with all tendons as well as the posterior tibial vessels and nerves lacerated. Because of the severe injury to the soft tissue, amputation was necessary.

A discussion of the mechanism of the injury indicates that the foot was violently displaced laterally with consequent fracture of the fibula and laceration of all the structures on the medial side of the foot from stretching. This permitted the expulsion of the entire astragalus from the foot.

In reviewing the literature the writer finds only 1 case in which the astragalus was completely dislocated and lying between the skin and the patient's sock. In this case the bone was replaced and a satisfactory result obtained.

[ED. NOTE: There is no doubt but that complete compound dislocation of the astragalus is more frequent than the surgical literature indicates. Such an injury is a major one, and the treatment and the functional results in a case of such an accident should always be reported.]

Milch [54] reviews the historical background of fractures of the processus posticus tali, pointing out that in the French literature this lesion goes by the name of Cloquet's fracture. In the English literature, however, credit is given to Shepherd, who reported this rare lesion at the Medical and Surgical Society of Montreal in 1882. The recent work of Carnevalli has supplied the microscopic evidence to confirm the opinion that this rare fracture actually does take place.

Shepherd attempted an experimental reproduction of this fracture and called attention to the facts (1) that the processus posticus tali is situated lateral to the groove of the flexor longus hallucis tendon, (2) that the size of the processus varies and (3) that the position of the fasciculus of the lateral ligament of the ankle joint was attached to the tip of the processus posticus of the astragalus. When the foot becomes plantar flexed, the posterior part of the astragalus rises upward and approaches the lower margin of the posterior surface of the tibia. Impingement of the tibial margin against the tip of the processus leads to a torque with consequent fracture at the side of the fulcrum.

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54. Milch, H.: Fracture of Processus Posticus Tali, M. Rec. **154**:90-92 (Aug. 6) 1941.

The condition must be diagnosed on the basis of the mechanism of injury, localized tenderness, pain with plantar flexion of the foot and also acute flexion of the great toe. Roentgen evidence should show a sharp irregular fracture surface as against the smooth outline of a typical os trigonum.

The author reports a case in which there is an unquestioned fracture of the processus. After ten days' immobilization in plaster, a check-up roentgen examination with the foot in equinus position and then in calcaneus position showed an upward shifting of the fragment in relation to the body of the astragalus when the foot was in the first position.

The prognosis is good after a short period of fixation in plaster. There is no indication for resection of the fragment unless it acts as a bony block.

DeAraujo [55] reports a case of isolated fracture of the external apophysis of the astragalus in detail, the second he has observed. The lesion is a rare one, there being only 5 cases reported in the literature. He emphasizes that diagnosis is difficult, most of the published cases having been confused with a tibiotarsal accessory bone, as was the first case reported by the writer. Careful examination of the anterior portion of the external malleolus will yield an excellent point from which to examine the astragalus and in particular the external apophysis. Palpation will reveal crepitation and a site of maximum pain. The author states that the lesion is caused by abnormal torsion movements of the astragalocalcaneal and calcaneoscaphoid articulations. In his second case there had been a sudden violent external rotation of the knee with the foot fixed on the ground, causing torsion of the subastragalar joint with fracture of the external apophysis of the astragalus. All 5 cases occurred in male patients in the second or third decades of life, and all fractures were on the left side. In all cases cure was effected in four to six weeks by simple immobilization. The accidents occurred during work. [ED. NOTE: This fracture is seen in industry probably more often than in civilian life. It occurs more often than reports in the literature indicate.]

Fractures of the Os Calcis.—Ahlberg [56] reports the results of final examinations in 111 cases in which there were one hundred and twenty-two fractures of the os calcis during the period 1925 to 1937. In the present article he deals with ninety-five fractures in 88 patients. The fractures are of a more severe variety with direct or indirect involvement of the joint roughly corresponding to Böhler's groups V to VIII. In at least 60 per cent the accident had taken place five years earlier.

55. deAraujo, A.: Isolated Fracture of External Apophysis of the Astragalus, Rev. brasil. de orthop. e traumatol. **2**:277-285 (March-April) 1940.

56. Ahlberg, A.: Therapeutic Results in Severe Fractures of the Calcaneum. Acta chir. Scandinav. **84**:187-198, 1940.

Complete anatomic restoration was not observed in any case, not even when early active therapeutic measures had been undertaken. Mobility in the subastragaloid joint was found to be normal in only 6 cases. In the rest it was either absent or limited. Mobility seems independent of whether the joint surfaces are anatomically restored or not. For years numerous patients had had painful symptoms after the accident, as a rule apparently caused by injuries of the joint. Changes in the joint occasioned by fracture seem to develop irrespective of the therapeutic methods and are according to the nature of the fracture. The author agrees with those writers who after the earliest possible reduction advocate performing subastragaloid arthrodesis four to five months after the accident if symptoms persist.

Campbell [57] reports 1 case of transverse fracture across the body of the calcaneus with upward-backward rotation of the posterior fragment. The fracture was reduced by insertion of a Steinmann pin horizontally in the back of the posterior fragment. With this pin as a lever, the tension against the heel cord was counteracted by a downward pull on the pin, and the whole was incorporated in the cast. Campbell includes no follow-up in the 1 case reported. [ED. NOTE: This seems to be a rather ingenious method of reduction applied to this particular situation.]

Fractures and Dislocations of the Spine.—Barber [58] reported a case of a fracture of the spine with dislocation of the first lumbar vertebra on the second lumbar vertebra and loss of motor and sensory function in the right leg. Attempted manipulation with the patient under anesthesia did not reduce the dislocation. When the vertebrae were exposed at operation, the dislocation was easily reduced, and the spinous processes were anchored with a wire loop to prevent redislocation. Pressure symptoms on the cord gradually disappeared, and the patient eventually made a satisfactory recovery. [ED. NOTE: This ingenious operation which overcame the disability is well worth while in the treatment of irreducible dislocations of the spine. The author makes the excellent point that the surrounding soft tissues are sometimes so lacerated that the vertebrae must be fastened together to prevent recurrence.]

Outland [59] emphasizes the importance of accurate diagnosis and early adequate treatment for fractures of the spine, indicating that too

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57. Campbell, W. G.: Simple Operation for Reduction of Fragments of Os Calcis, Brit. M. J. **2**:651-652 (Nov. 8) 1941.

58. Barber, C. G.: Open Surgical Reduction of Fracture-Dislocation of Lumbar Spine with Cord or Cauda Equina Involvement, Am. J. Surg. **52**:238-245 (May) 1941.

59. Outland, T.: Treatment of Compression Fractures of Spine, Pennsylvania M. J. **44**:866-868 (April) 1941.

many of these patients are treated by surgeons who are insufficiently trained in fracture operations. He indicates that residual disability is due to one of three things: (1) actual deformity causing angulation of the spine; (2) disturbance of the lateral intervertebral joints due to subluxation; (3) neurotic fixation. He prefers to use a local anesthetic, injecting 30 to 40 cc. of 0.5 per cent procaine hydrochloride directly into the hematoma. He says this is not a difficult procedure and can be readily done. The reduction is carried out with the patient in a prone position, and a body cast is applied with great care. The author stresses the importance of after-care and feels that it is particularly important that the patient be allowed to be up immediately and even to undertake light work. In the absence of this active regimen definite exercises are given and carefully supervised in order that there be good function when the cast is removed from three to six months later. He feels that ordinarily a brace is not necessary and in fact may often do harm, psychologically at least. [ED. NOTE: This review is included because several of us fully disagree with the author with regard to early weight bearing. Few patients with compressed fractures of the spine should be allowed early weight bearing. Also a cast or brace should be worn until sufficient union has taken place. Serious complications can result from failure to observe these measures.]

Greenwood [60] describes a simple method of fixation of the spinal column in hyperextension for compression fractures of the thoracic and lumbar vertebrae. A double Balkan beam, a table and plaster of paris are necessary. The patient is placed in the supine position. Anterior and posterior plaster slabs are placed on the trunk, the anterior extending from the suprasternal notch to the symphysis pubis. While these are setting, a heavy cloth bandage is carried as a sling around the posterior slab at the fracture site and brought up over the horizontal bars of the double Balkan beam, and the body is raised until the buttocks and the shoulders swing clear of the table. When the two heavy plaster slabs have become firm enough to retain their shape, they are incorporated in a circular plaster body cast.

The author stresses the simplicity of the method and the fact that the patient is in the more comfortable supine position. It is especially suitable for patients with mental diseases who have sustained thoracic fractures during convulsive shock treatment for schizophrenia and other conditions.

Gullikson and Anderson [61] review various methods of treatment of fractures of the spine and report end results in 34 cases. Their suggested method is the use of a suspension sling (as for fractures of the

60. Greenwood, H. H.: Fixation of Fractured Vertebrae, Lancet **1**:754 (June 14) 1941.

61. Gullikson, J. W., and Anderson, E. R.: Compression Fractures of Dorsolumbar Vertebrae, West. J. Surg. **49**:576-580 (Oct.) 1941.

pelvis) with production of gradual hyperextension. The application of 40 to 50 pounds (18.1 to 22.7 Kg.) to an overhead traction pulley arrangement is advocated. The authors contend that this is more comfortable than the Bradford frame and safer than rapid reduction with the patient under anesthesia. After four to ten days a body jacket is applied with the patient on a Roger's hammock frame. Ambulation is permitted in two to three days. At the end of two to three months a Taylor brace is fitted; this is worn for about two months. Return to work is usually possible six to eight months after injury.

Analysis of the cases of 34 patients with an average age of 45.2 years showed an average disability period of eight and two-tenths months. Thirty-two of the patients returned to their former work, and 16 were symptom free. Fifteen had occasional backaches, and 2 were unable to return to their regular duties. Associated skull fractures were found in 7; 14 had more than one vertebra fractured, and 2 had early symptoms of compression of the cord. One patient was operated on because of the damage to the cord and recovered. There were no deaths. The Soto-Hall sign (acute flexion of the neck producing pain at the fracture site) is stressed as a diagnostic aid.

Haggart [62] reports in detail a fracture-dislocation of the lumbar spine with forward displacement of the third lumbar vertebra on the fourth, and fragmentation of the laminas and articulations between the third and fourth lumbar vertebrae associated with incomplete paralysis of the lower extremities and loss of bladder and anal sphincter control. The patient was seen three weeks after injury, and after tidal drainage of the bladder was instituted, open operation was performed with reduction of the fracture-dislocation. Reduction was maintained by wire lashed in a crossed fashion through the spinous processes of the third and fourth lumbar vertebrae in addition to fusion of the spine with bone chips obtained from the right posterior part of the ilium.

The end result one year after operation disclosed the patient as ambulatory without support. There was complete control of the sphincters and only slight weakness of the right leg. Roentgen examination showed firm bony fusion of the lumbar portion of the spine with maintenance of the reduction.

[Ed. Note: This case represents one of the positive indications for operative procedure in the treatment of spinal injuries. Manipulation, no doubt, would have caused increased damage to the cauda equina and failure of reduction of the dislocation. The fusion of the spine following the reduction may not have been absolutely necessary, but in this patient with extensive osteoarthritis the end result no doubt was better because of fixation of the lumbar portion of the spine.]

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62. Haggart, G. E.: Fracture-Dislocation of the Lumbar Spine, Open Reduction and Fixation by Spine Fusion: Case Report, Lahey Clin. Bull. **2**:177-185 (Oct.) 1941.

Wortis and Sharp,[63] in a comprehensive review, study 200 cases of fractures of the spine at various levels. Of particular interest is the curve of incidence of specific areas of injuries which shows the commonest sites to be at the levels of the second cervical and the sixth cervical vertebra and in the dorsolumbar region. Of 52 patients with fractures of the cervical portion of the spine 75 per cent showed evidence of injury to the spinal cord or root. Seventy-five per cent of the patients who had neurologic signs died. Fifty per cent of the patients with cervical injuries showed evidence of cerebral concussion. In the 40 cases in which there was a fracture of the thoracic portion of the spine 58 per cent of the patients showed evidence of the injury to the spinal cord or root, and in this group 52 per cent of those with neurologic signs died. Of the 104 patients with fractures of the lumbar portion of the spine only 24 per cent showed evidence of injury to the spinal cord, and only 1 patient died. All 4 patients with fracture of the sacral part of the spine recovered; none presented neurologic signs.

Of the 15 patients on whom laminectomy was performed only 2 showed improvement. This led the writers to adopt a conservative attitude. Surgical intervention, which should always be done extradurally, is indicated: (1) when the lamina of the spine is fractured, causing cord compression, in which case hyperextension is apt to increase pressure on the cord; (2) when there is an incomplete cord lesion and definite evidence of bone fragments in the spinal canal; (3) when the patient with signs of an incomplete lesion of the cord shows evidence of progressive cord dysfunction despite reduction and immobilization (this group is the only one in which manometric studies of the spinal fluid are of value); (4) when bony compression injures the fibers of the cauda equina, and (5) when there is intractable pain in the root secondary to fracture of the body or of a lamina. One important fact which is emphasized is that with hemorrhage in the spinal cord this hemorrhage is most apt to extend into the gray matter. When flaccid paralysis rather than spastic paraplegia is present, the prognosis is grave. A patient in this condition should never be operated on.

Some of the indications for late operative intervention are as follows: (1) callus encroachment in the spinal canal giving slowly increasing neurologic signs; (2) callus encroachment on the spinal root with intractable pain; (3) herniation of an intervertebral disk; (4) hypertrophy of the ligamentum flavum with increased pressure of the spinal cord; (5) post-traumatic adhesive arachnoiditis.

The writers urge optimism in spite of what at first appears to be a severe injury to the spinal cord. Conservative care is stressed unless

63. Wortis, S. B., and Sharp, L. I.: Spine Fractures: Study of Two Hundred Cases, J. A. M. A. **117**:1585-1591 (Nov. 8) 1941.

there is positive indication for laminectomy. There is less reason for optimism in cases of flaccid paraplegia and in the presence of the Gordon Holmes slow flexion reflex. The presence of a Babinski sign in the first three weeks after severe injury is a good omen. [ED. NOTE: This is a splendid review of spinal injuries from the neurologic standpoint and is especially valuable for its presentation of prognostic signs, the wisdom of its conservatism and its limitation of indications for laminectomy.]

Hatchette[64] points out that isolated fractures of the atlas are extremely rare, there being only 99 cases reported since 1822. He discusses the reasons for infrequent injury to this bone: first, that there is no body to be damaged by wedge action of forward flexion; second, that the major force of the blow vertically is divided between the two wedge-shaped lateral masses which give good support. He indicates that the causation of fracture is forcible vertical pressure, separating the two lateral masses, and so fracturing the ring of the atlas. One case is reported.

Weissberg and Reinstein[65] outline the accepted theories of spontaneous subluxation of the atlantoaxial articulation or Grisel's syndrome. This was first reported by Wittek in 1908 and is a rare cause of wryneck. The theories are: (1) effusion into the joint with overdistention of the ligaments; (2) incoordinate reflex action; (3) contracture of the suboccipital muscles secondary to nasopharyngeal lymphadenitis, and (4) rupture of the transverse ligament at the atlas.

The actual dislocation is preceded in most instances by infection of the upper part of the respiratory tract. It is seen most frequently in children, although the authors' patient was a white man aged 52 years. One week before admission to the hospital this patient had infection of the upper part of the respiratory tract. This was followed in two days by acute pain, muscle spasm and complete fixation of the cervical portion of the spine. Roentgen examination disclosed forward displacement of the body of the atlas on the axis. Reduction was easily accomplished, as is usually the case, by continuous head traction followed by plaster fixation. [ED. NOTE: Approximately 30 cases have been reported up to the present time, and one of us (H. E. C.) had a similar lesion in a youngster in whom spontaneous anterior dislocation developed after a prolonged illness when the sitting position was assumed. In another case a 19 year old girl had infection following tonsillectomy. In the latter patient paralysis of the upper extremities developed. This cleared up with rest in bed and traction. Later a rigid support was applied to the neck and the back.]

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64. Hatchette, S.: Isolated Fracture of Atlas, Radiology **36**:233-235 (Feb.) 1941.

65. Weissberg, J., and Reinstein, H.: Spontaneous Dislocation of Atlanto-Axial Articulation: Report of Case, New York M. Coll. & Flower Hosp. Bull. **3**:306-308, 1940.

Six cases of dislocation of the cervical vertebrae are reported by Willard and Nicholson [66]—3 each of the traumatic and spontaneous types. No neurologic symptoms were noted, and reduction was possible in all cases except 1 in which it could not be maintained because of an uncooperative patient with subsequent death from pneumonia. All the traumatic dislocations were associated with fractures of the odontoid process. The 3 spontaneous dislocations followed infections of the upper part of the respiratory tract and cervical adenitis. One dislocation was posterior with associated fracture of the odontoid.

The treatment except in the patient with the posterior dislocation was by the dependent head method previously described by Nicholson which permits gentle spontaneous reduction in twenty-four to forty-eight hours with the head gradually extended over the edge of two or three mattresses placed on a fracture bed with the patient held in position by Buck's extension. Following reduction plaster fixation from the head to the pelvis for twelve to sixteen weeks and the use of a Thomas collar for six to eight weeks are recommended. In 1 case with three recurrences in fifteen months, the method of Mixter and Osgood was utilized, the arches being lashed together with a strip of fascia lata.

This presentation in addition to giving detailed case studies reviews the classification, the causation, the anatomic features, the diagnosis and the treatment in a thorough manner. The outstanding features were the infrequency of neurologic complications, the safety and the ease of spontaneous reduction with the head hanging dependent (except in cases of posterior dislocations) and the operative fixation with fascia lata in cases of recurrent dislocations.

Wright and Wunderly [67] describe a mobile traction apparatus for use in treating fractures or dislocations of the cervical vertebrae. The device has for its basis traction through a palatal piece which fits over the teeth of the upper jaw; this gives fixed traction to the cranial skeleton, which withstands considerable pressure without injury, and a broad flat base on the occiput for countertraction. A plate bearing evenly on the teeth of the upper jaw is made of aluminum and is attached to two stainless steel arms, curving about the cheeks and attached to a molded aluminum trough lined with thick sponge rubber in which the occiput rests. The molded frame is mounted on a roller skate to give mobility to the apparatus. To this frame a bow of meccano iron is fixed to pass around the forehead; to the bow are attached the cheek bars of the palatal part. It is also suggested that

66. Willard, DeF. P., and Nicholson, J. T.: Dislocation of First Cervical Vertebra, Ann. Surg. **113**:464-475 (March) 1941.

67. Wright, R. D., and Wunderly, J.: Treatment of Fracture or Dislocation of the Cervical Vertebrae, M. J. Australia **2**:532-534 (Nov. 23) 1940.

instead of the trough for the occiput being made out of aluminum one be made out of a plaster mold. In edentulous upper jaws the palate should be completely covered with an aluminum plate rather than just the palatal bar. The advantages are ease of modification of flexion and extension of the neck as well as alteration of the pull from side to side. The mouth can be opened easily for eating and speaking, and the palatal part can be removed for hygienic care of the upper teeth.

A report of a case is given in which the patient was a 14 year old girl with a fracture-dislocation of the fourth and fifth cervical vertebrae and a compression fracture of the seventh cervical vertebra seen seven weeks after injury. With the palato-occipital traction apparatus, gradual increasing weight up to 16 pounds (7.3 Kg.) was possible with little discomfort. Satisfactory reduction was obtained.

[ED. NOTE: This complicated apparatus makes it necessary to obtain an impression of the upper dental arch and to construct from this a palatal bar of aluminum or vulcanite.]

Metrazol Fractures of the Spine.—Read[68] reports on the consequences of metrazol therapy in a long series of 320 patients with schizophrenia. He points out that in 20 to 30 per cent of cases in which metrazol therapy is used vertebral fractures develop. However, after this percentage was realized, the last 50 patients treated apparently had no fracture whatever. They were supported by being firmly held to a sandbed, indicating that with proper support the percentage of fractures should drop materially. [ED. NOTE: This is a careful report and seems to indicate that with the recognition of the danger the percentage of vertebral fractures markedly diminished in many of these conditions of the convulsive type.]

To determine the frequency and the seriousness of complicated vertebral fractures in patients with epilepsy of the grand mal type, Moore, Winkelman and Solis-Cohen[69] selected 12 such patients at random. Ninety-two per cent showed some form of vertebral injury; 66.67 per cent showed definite compression fractures of the thoracic and lumbar vertebrae. In all but 1 case there were no symptoms referable to the vertebral column. There were no orthopedic or neurologic disturbances as a result of these vertebral defects.

The purpose of their study is to defend the use of metrazol in the treatment of types of neuropsychiatric conditions in which it has shown itself to be of considerable value. In spite of the frequency of spinal injuries with this therapy, it is thought justified to continue its use,

68. Read, C. F.: Consequences of Metrazol Shock Therapy, Am. J. Psychiat. **97**:667-676 (Nov.) 1940.

69. Moore, M. T.; Winkelman, N. W., and Solis-Cohen, L.: Asymptomatic Vertebral Fractures in Epilepsy, Comparison with Vertebral Fractures Due to Metrazol Induced Convulsions, J. Nerv. & Ment. Dis. **94**:309-323 (Sept.) 1941.

and a suggestion is made how to avoid compression fractures as much as possible. This consists of using a hard even mattress with fracture board between it and the springs so that there will be no chance for acute flexion during the convulsive seizure. In addition, attendants hold the patient squarely on his back and also control the lower jaw to prevent fracture of the mandible and biting of the tongue.

[ED. NOTE: While in most instances acute flexion may account for the compression fractures, often during the convulsive seizure the patient remains straight, and the injuries which occur are due to violent muscle spasm rather than to assumption of the jackknife position.]

Fractures of the Jaw.—Coleman [70] states that in 1913 he described a sign for fracture of the mandible ignored in textbooks except in the recent treatise by James and Fickling.[71] The sign is produced by an effusion of blood into the tissues of the floor of the mouth and gives rise to a characteristic appearance of its mucous membrane, which becomes raised and forms a bluish, tense and elongated swelling under the side of the tongue. The sublingual fold lying between the tongue and the mandible is the part chiefly involved in this effusion. This sign alone will serve to differentiate an external bruise from an injury producing a fracture of the jaw.

In 1909 the author devised a clamp for fixing the fragments of a broken jaw. The clamp consisted of a strong steel spring which could be opened to enclose the fractured ends of the bone and which when released embedded itself in the mucous membrane and bone by means of its projecting claws. The method of applying the clamp is described. The clamp has been slightly modified since making it a little more powerful and facilitating removal. It must be removed by the operator.

McGrail and Doherty [72] discuss the difficulty of accurate roentgen visualization of fractures through the neck of the mandible, which is the most common type of fracture of the jaw. They suggest the following technics: (1) the technic used for visualization of the mastoid region with the tube at an angle of 45 degrees; (2) a technic in which the casette is parallel to and against the side of the face, the central ray passing through the sigmoid notch and the chin being turned toward the tube; (3) visualization of the zygomatic arch with an intraoral technic. In the last-named method the dental film is held in the teeth, projecting out into the cheek as far as possible, the tube being aimed from above and the head being deviated slightly away from the injured

70. Coleman, F.: Fractured Mandible: Sign of and Method of Treatment, Proc. Roy. Soc. Med. **34**:212-214 (Feb.) 1941.

71. James, W. W., and Fickling, B. W.: Injuries of the Jaws and Face, London, John Bale & Staples, Ltd., 1940.

72. McGrail, F. R., and Doherty, J. A.: Roentgenograms of Mandibular Condyle and Zygomatic Arch, Am. J. Roentgenol. **45**:637-639 (April) 1941.

side. Views taken by these three technics give accurate roentgen visualization of the fractured area and permit accurate analysis of the type of injury.

Strock [73] emphasizes the importance of simplifying the forms of treatment which may be applied to simple or complicated fractures of the mandible. He illustrates the displacement of the fragments at various levels and how they are influenced by muscular pull. The direction of the line of fracture also governs the displacement.

Two principles, namely, prompt reduction and simplicity of immobilization, are stressed. The latter is accomplished by intermaxillary wiring. Buttons are made by carefully twisting the properly placed loops of wire, and onto these are looped short elastic bands as used in orthodontia. Bands may also be cut from rubber tubing. With this arrangement the jaws are held in occlusion without force, and the slight movement possible stimulates healing.

The most important guide to proper alinement is occlusion. It is important to know whether abnormal occlusion was present before the fracture. The rule without exception is that no tooth without an occluding tooth in the opposite jaw should be used to support a button to which elastic traction is applied. Intermaxillary elastics are easily replaced to permit more thorough cleansing of the oral cavity and give a constant, thorough and gentle force in fractures delayed in reduction. The author considers shorter immobilization desirable, having removed the wires within fifteen days in some cases.

Griffin [74] describes an ingenious technic in which a special skeletal fixation splint is used for reduction and fixation of fractures of the mandible which permits free movement of the lower jaw, thus making it possible for the patient to masticate semisolid foods as well as permitting more adequate oral hygienic care.

The apparatus consists of either stainless steel or vitallium fixation screws applied externally through small incisions into each fragment; to these are attached a cross block with the usual screw adjustments in order to bring the fragments into apposition. The entire apparatus weighs approximately 1½ ounces (46.7 Gm.), which is not sufficient to interfere with movements of the mandible. Following removal of the screws after union is adequate to permit discontinuance of the use of the apparatus, the four stab incisions are freshened and sutured with fine dermal sutures. According to the author the indications for the use of this technic are unlimited, but it is particularly valuable in fractures of the molar or premolar region with long edentulous posterior frag-

73. Strock, M. S.: Fractures of the Mandible, Surg., Gynec. & Obst. **72**:1047-1051 (June) 1941.

74. Griffin, J. R.: Treating Fractures of Mandible by Skeletal Fixation, Am. J. Orthodontics (Oral Surg. Sect.) **27**:364-376 (July) 1941.

ments or in completely edentulous jaws, where wiring is impossible. The method is particularly indicated in compound fractures, such as gunshot wounds, in which large fragments of bone may have been lost. It is considered an ideal type of splinting following a bone graft for nonunion. Three cases are reported and generously illustrated; the results were apparently satisfactory.

Mowlem and associates [75] describe an apparatus for fixation of fractures of the mandible extraorally in patients who have no teeth and in whom the fracture occurs behind the tooth-bearing area. A pair of crossed Kirschner wires are inserted into each fragment; these in turn are locked on plates which are attached together by an intervening fixation bar. The advantage of the apparatus is the relative comfort obtained without locking the mandible to the upper jaw, thus permitting oral cleanliness and eating with ease. The locking plate and the fixation bar are made of aluminum alloy and together weigh less than ½ ounce (15.5 Gm.). The minute scars made by the Kirschner wires are easily excised and negligible. This apparatus has been used by the writers in 19 cases. They suggest that its use be limited to those fractures which cannot be adequately controlled by standard methods.

Ivy [76] writes that preparations have been made in the office of the Surgeon General of the United States Army for a more systematic plan of treatment of gunshot wounds of the jaws than that used in the first World War. Special training is being given to medical and dental officers and enlisted men in the medical department, who will be assigned to units from the combat zone back to the general hospital. Ivy covers the plan of treatment from the front lines to the surgical hospital where a maxillofacial team consisting of a surgeon and a dental surgeon trained in this type of work are stationed. Points demanding special attention in the combat area have been listed as (1) arrest of hemorrhage, (2) provision of adequate respiratory airway, (3) temporary approximate reduction and fixation of bone fragments and (4) provision of safe transportation from the combat zone to a hospital in the rear.

Arrest of hemorrhage as a general rule may be accomplished by pressure from a gauze pack; but for hemorrhage from larger vessels the use of clamp and ligature may be required. In patients with respiratory embarrassment it is suggested that with loss of control of the tongue, as in an unconscious patient, a long suture be placed through its tip so that it may be brought forward and attached to the dressing.

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75. Mowlem, R.; MacGregor, A. B.; Buxton, J. L. B., and Barron, J. N.: External Pin Fixation for Fractures of the Mandible, Lancet **2**:391-393 (Oct. 4) 1941.

76. Ivy, R. H.: First Aid and Emergency Treatment of Gunshot Wounds of Jaw, Mil. Surgeon **89**:197-201 (Aug.) 1941.

With excessive swelling of soft tissues a rubber tube may be inserted through the nose or the mouth to the nasopharynx. Tracheotomy should be used only as a last resort.

The approximate reduction and fixation of fragments will be dependent on whether a dental surgeon is available. The preservation of all comminuted viable fragments of bone which may be used in the final reconstruction procedure is stressed. A simple emergency splint may be constructed by the use of two or three tongue depressors secured to the frontal region, extending down in front of the chin, and to this may be attached a ligature wire which has been passed through the lower front teeth or around the chin segment of the mandible, thus preventing backward displacement. In case of fracture of the upper

Results of the Treatment of Compound Fractures in Jackson's Series of Cases

Type of Treatment	No. of Cases	Pyogenic Infections		Gas Bacillus Infections		Secondary Amputations		Number of Deaths	No. of Cases in Which Internal Fixation Was Used	Average Hospital Stay, Days
		No.	Per Cent	No.	Per Cent	No.	Per Cent			
1. Debridement	50	27	54	5	10	5	10	3	0	37.7
				Two treated with x-ray and recovered; two died; one amputation with recovery						
2. Debridement and prophylactic x-radiation	57	9	15.8	0		0		0	0	19.8
3. Debridement, prophylactic x-radiation and oral sulfanilamide	16	7	43.7	1	6.3	0		1	0	22
4. Debridement and local implantation of sulfanilamide	54	3	5.6	0		0		0	11	6.8

jaw this may be attached to the upper teeth in a similar manner. The safe transportation from the combat zone to the hospital for the final definite treatment should be the same as for any other type of injury, except that semiambulant patients do better if permitted to sit up. If recumbency is necessary, the prone position is most desirable.

[ED. NOTE: This detailed discussion of first aid and emergency treatment should be read by every medical officer who in the present conflict may be assigned to duty in the combat zone.]

Compound Fractures.—Jackson [77] reviews the types of treatment for compound fractures. Her whole article is summed up in the table herewith presented and the statement that local implantation of sulfanilamide in compound fractures after debridement marks the greatest progress in the history of the treatment of compound fractures.

77. Jackson, R.: Comparative Study of Treatment of Compound Fractures, South. M. J. **34**:319-323 (March) 1941.

Stich [78] gives a brief historical résumé of the methods of treatment of gunshot wounds of the knee and the lower extremities, stating that the best results have been obtained by aseptic dressings and immobilization in plaster. Of particular interest in the historical discussion is the information that during the Revolutionary War 837 of 1,000 patients with gunshot injuries of the knee died. The author adds to the emergency care the injection of 0.5 per cent procaine hydrochloride into the wound from a normal skin area as a method of treating shock. He also injects from 40 to 60 cc. of prophylactic antigas bacillus serum into the muscles about the site of injury. Only in large wounds of the joints without much destruction of bone does he recommend excision of the outer wound and closing the skin and eventually the capsule with a few wide sutures. In the majority of gunshot fractures thorough debridement is possible up to twelve hours, but suturing is contraindicated. The author does not recommend cod liver oil dressing of fresh war wounds even after a careful wound toilet. In cases in which the wound is left wide open, suturing may be done after a few days if there is no fever and the patient is somewhat restored.

Progress since 1860 in the treatment of open fractures is shown by the facts that Bilroth reported 219 cases occurring between 1860 and 1867 with a mortality rate of 68.8 per cent and amputations in 20 per cent, that at the Zurich Clinic between 1899 and 1929 there were 675 cases with a mortality rate of 14.9 per cent and amputations in 18.5 per cent and that Böhler and Ehalt reported 307 cases occurring up to 1937 with a mortality rate of 3.5 per cent and amputations in 4.58 per cent.

Wallis and Dilworth [79] have used sterile gauze dressings soaked in 12 per cent solution of lactose to pack into the wounds of compound fractures and chronic osteomyelitis. It is stated that since bacteria prefer to feed on sugar rather than on proteins there is less putrefaction. They report less odor during the Orr treatment and no impairment in healing. The dressings do not become adherent to the wounds. [Ed. Note: Some observers, however, report that the difference in odor with this treatment is not appreciable and that the gauze does stick to the granulation tissue. This is worth a trial by all surgeons treating infected wounds.]

Venable and Stuck [80] discuss the use of vitallium plates and the local implantation of sulfanilamide in the treatment of compound fractures.

78. Stich, R.: Therapy of Gunshot Fractures of Extremities, Med. Welt **15**: 29-32 (Jan. 11) 1941.

79. Wallis, A. D., and Dilworth, M. J.: Lactose for Prevention of Odors in Closed Cast Treatment of Compound Fractures, Brit. M. J. **1**:750-751 (May 17) 1941.

80. Venable, C. S., and Stuck, W. G.: Use of Vitallium Appliances in Compound Fractures, Am. J. Surg. **51**:757-766 (March) 1941.

They do not advise this as a routine procedure. Formerly they allowed compound wounds to heal by scar tissue which bound the skin to the bone; now they apply the plates through a clean incision away from the contaminated area and treat the compound wound separately. They conclude that vitallium is a safe metal to place in compound fractures when used in this manner. They further report in a study of 1,227 patients with fractures of all types, including compound, treated by sixty surgeons with vitallium appliances that 92.6 per cent gained solid union, 3.8 per cent showed delayed union and 3.6 per cent ended in nonunion (reportedly not the fault of vitallium). [ED. NOTE: This is evidence in favor of the mechanical fixation of bad compound fractures when combined with chemotherapy.]

Pulaski and Chandlee [81] report on zinc peroxide in the treatment of compound fractures and traumatic amputations. They state that zinc peroxide not only has a "continuous inhibiting effect on the hemolytic streptococcus, the gas gangrene organisms, and other anaerobic bacteria, but has as well bactericidal and detoxifying action." It has no general toxicity or local irritation. The wounds were flooded with freshly prepared zinc peroxide after a thorough debridement. Internal fixation was used sometimes. The zinc peroxide used must be a reliable preparation. It should be used as a suspension creamy enough to reach every part of the wound and should be kept wet since moisture is necessary for the liberation of oxygen. It is not absorbed and should not be used in closed wounds. The results in 18 cases (10 were cases of injuries of the phalanges) were sufficiently encouraging to warrant continuing the use of zinc peroxide prophylactically in the prevention of infection in fractures. [ED. NOTE: This method apparently did not receive a thorough test by the authors in treatment of severe compound wounds, i. e. those of the tibia and the femur.]

Experimental.—Caldwell [82] produced the counterpart of a compound fracture in the femur of guinea pigs and infected the wounds with a lethal number of Clostridium welchii. Debridement of the wounds followed by implantation of 15 to 30 mg. of sulfanilamide crystals and closure resulted in survival of only 4 of 19 animals (all controls died). Debridement and irrigation of similar wounds left open and followed by the administration of 50 mg. of sulfanilamide intraperitoneally every six hours allowed survival of 7 of 9 animals (8 of 10 controls died). Debridement and irrigation of such wounds followed by implantation of zinc peroxide paste and suture of the wounds resulted in the survival

81. Pulaski, E. J., and Chandlee, B. H.: Zinc Peroxide in Treatment of Compound Fractures and Traumatic Amputations: Report of Eighteen Cases, Surgery **10**:904-916 (Dec.) 1941.

82. Caldwell, G. A.: Treatment of Gas Gangrene Experimentally Produced, J. Bone & Joint Surg. **23**:81-85 (Jan.) 1941.

of 4 of 5 animals. Similar wounds sutured and treated with roentgen therapy in varying doses (100 to 200 r one to three hours after inoculation) resulted in the death of 7 of 10 animals (all controls died), and the wounds of the surviving animals healed with dry necrosis of the skin and deep sloughing in the muscle layers. The author concludes from these experiments that the intraperitoneal use of sulfanilamide and the implantation of zinc peroxide into the wound are most efficacious and that of the two zinc peroxide is more satisfactory. [ED. NOTE: This is excellent experimental evidence of the value of sulfanilamide crystals and zinc peroxide paste in infected wounds.]

Fracture Teaching.—Murray [83] calls attention to the excellent work done in the past several years by the Committee on Fractures and Other Traumas of the American College of Surgeons. It is carried on through the activities of the various regional subcommittees of the American College of Surgeons. He further states that however good this effort has been it has been markedly inadequate. He calls attention to the fact that many medical students receive inadequate instruction in fracture training and that this is not greatly improved in the intern years. This is of particular importance since it is well known that the average fracture is treated not by the fracture specialist but by the general practitioner, whose sum total of training in fractures consists of what he has acquired in medical school and during an ordinary internship without special education along the lines of traumatic surgery. This being the case, it is especially important that the fracture service be well organized, that the student be given an opportunity to examine the fractures at first hand and even to take part in their treatment and particularly that the intern in the hospital be permitted to observe fractures under the close supervision of a well trained fracture surgeon. Murray points out that the treatment of fractures is as much a part of general practice as the treatment of obstetric conditions or pneumonia but that education is much deficient with regard to the treatment of fractures whereas it devotes considerable attention to the treatment of these other conditions. In summation he makes a plea for the following measures: (1) instruction in the correlation between the pathologic nature and the repair of fractures and the symptoms and the indications for treatment of fractures; (2) correlation between the diagnosis and the treatment of fractures and the gross anatomic characteristics; (3) instruction in the basic principles underlying all fracture treatment, preferably by demonstration on actual patients; (4) adequate follow-up of actual patients from the time of reduction of the fracture until the end result is obtained; (5) opportunity

83. Murray, C. R.: Undergraduate Education in Fractures and Other Traumas, Surg., Gynec. & Obst. **72**:399-401 (Feb., no. 2 A) 1941.

to see late results on similar patients; (6) actual instruction and practice in application of the Keller-Blake and Murray-Jones traction splints; (7) some organized training in first aid and the treatment of trauma, preferably in the sophomore or junior years. [ED. NOTE: This is an excellent discussion and a timely plea for more active training in the treatment of trauma, particularly emphasizing the fact that undergraduate education in this respect has been incomplete and must be improved.]

Operative Fixation of Fractures.—Murray [84] presents material and conclusions reached by the fracture service of the Presbyterian Hospital and Sloane Hospital for Women, New York, in the treatment of approximately 13,000 fractures, over 600 of which were treated by open reduction. He attempts to give an evaluation of the relative advantages of primary operative fixation and the so-called close reductions. He immediately divides the patients with fractures into two groups: In the first group are those patients who must be operated on because of necessity, i. e. (1) those with fixed interposition of tissue between the bone ends; (2) those in whom adequate reduction has not been secured by conservative methods; (3) those whose fractures experience has shown require operative reduction; (4) those with soft part injuries, and (5) those with compound fractures. He eliminates this group entirely from the discussion. The second group are those in which primary operative reduction is selected as the method of choice, although conservative treatment has been considered. He considers four questions of vital concern and answers them in some detail. The four questions are: (1) What are the theoretic advantages of open fixation? (2) Can advantage be taken of these theoretic advantages without undue risk to the patient? (3) What conditions are essential to carrying out the operation? (4) How can these conditions be established in any given institution?

In answering the first question he covers the problem by stating that the ideal reduction would be one in which the fragments went together without trauma and in which they were held adequately, permitting immediate function. Obviously, this cannot be carried out completely in any method. The disadvantages of the closed method are prolonged immobilization and frequent inadequacy of reduction, resulting in lesions of the soft parts incident to forced manipulation. The same disadvantages apply to a lesser extent when pins or wires are used and incorporated with plaster. Traction-extension methods may cause a minimum of tissue damage but often do not result in good reduction and also permit only incomplete immobilization of the joint. There is likewise the additional risk of infection, which with proper technic

84. Murray, C. R.: Primary Operative Fixation in Fractures of Long Bones in Adults, Am. J. Surg. **51**:739-747 (March) 1941.

should be minimal. He concludes that operative fixation is the only method which simultaneously provides atraumatic anatomic reduction with coincident abolition of a large part of the pathologic processes in the tissue, rigid fixation of the fracture and extremely early and full mobilization of the extremity involved.

The second question he answers by saying that these theoretic advantages can be used in a practical manner, as has been demonstrated in his own clinic. He names certain fractures, namely, those of both bones of the leg, those of the femur and those of the humerus. These resulted in: (1) better anatomic results; (2) fewer long-standing disabilities; (3) shortening of convalescence; (4) increased speed in healing time, as shown by roentgen examination and less delayed union and nonunion. The technic has been perfected to the point where the contraindications to be considered are: (1) the patient as an operative risk; (2) the skin conditions, and (3) the features of the fracture itself which make it doubtful that it can be fixed by rigid fixation.

In answer to the third question he insists that operation should be done within a few hours. The most rigid operative technic is of course essential to minimize the danger of infection. Further, it is necessary to get absolute accurate reduction without trauma, rigid fixation with strong internal fixation material and fixation in two planes to prevent torsion. This demands all of the meticulous care such an apparatus requires and early weight bearing with the extremity protected by a well fitted brace with the patient instructed adequately in its use.

In answer to the fourth question he says that it is absolutely essential that there be close cooperation between the doctor and the institution. It is of course essential that the surgeon be well trained in this technic and that he use it with care. It is equally important that the equipment of the institution provide the facilities not only for operation but for after-care.

Murray's conclusion is that, given these cooperative circumstances, these theoretic advantages can be safely translated into practical benefit to the patient sufficient to justify the use of the method under certain definite conditions. He emphasizes particularly that if these certain specific conditions cannot be met primary operative fixation is not the method of choice and that some conservative method should be adopted.

[ED. NOTE: This is a comprehensive discussion of this problem by one who is convinced that primary operative fixation is the treatment of choice. Many surgeons will find great difficulty in fulfilling all the requirements he mentions. However, Murray certainly has proved his case and by virtue of the exacting conditions he lays down has demonstrated also that use of these methods must of necessity be limited to a rather select group of surgeons and institutions.]

Obstetric Fractures.—Grossman [85] discusses various types of fractures of the newborn including the rather common fractures of the femur and the clavicle and the rather uncommon fractures of the humerus, the tibia and the fibula. He is of the opinion that the majority of these result from intrauterine manipulation of the child. He emphasizes the fact that they heal promptly with massive callus. The major complication to be feared is involvement of the skin by undue pressure. The prognosis is uniformly good.

Parachute Injuries.—Tobin, Cohen and Vandever [86] in a preliminary survey of injuries sustained during the first year of parachute jumping find that in 4,490 parachute jumps there have been a total of 121 injuries, 2.4 per cent. Thirty-two of the patients in this group were injured severely enough for admission to the hospital. Seventy-eight per cent of the patients admitted had fractures. Malleolar injuries totaled 40 per cent, while injuries of the tibia and the fibula constituted 8 per cent and injuries of the lateral condyle of the tibia represented 4 per cent. There was only 1 fracture of the os calcis; this was complicated by fractures of the scaphoid, the cuboid and the metatarsals. One anterior dislocation of the hip joint occurred owing to the violent wrenching of the parachutist's harness when the emergency chute was opened after he had remained suspended to the tail of the plane for approximately ten minutes. The remaining fractures were of relatively minor nature, 16 per cent being of the metatarsals and the phalanges.

The authors have reviewed all of the available foreign literature and classify the injuries into four major groups, as suggested by René de Gaulejac: (1) injuries resulting in death occurring as a result of entanglement with the plane or crashing to the earth when the parachute failed to open; (2) abdominal thoracic injuries with or without nervous or vascular complications produced by the shock of the opening of the parachute; (3) various organic lesions developing during the third phase of the jump, i. e. after the parachute had opened; (4) the more or less complicated injuries of the lower extremities resulting during the fourth phase of the jump as a result of contact with the earth.

There was a decrease in the percentage of the injuries during the last month of parachute jumping. This was attributed to improved methods of preliminary training which constitutes ground training with jumps from platforms of 4 to 6 feet (121.92 to 182.88 cm.) and from towers 250 feet (76.2 meters) high in an open parachute. The conditions simulate exactly a jump from a plane. In this preliminary training the student is taught the method of landing in order to take up shock. He is instructed to land on the balls of both feet, which should be shoulder

85. Grossman, J.: Fractures in Newborn, M. Rec. **153**:85-87 (Feb. 5) 1941.

86. Tobin, W. J.; Cohen, L. J., and Vandever, J. T.: Parachute Injuries, J. A. M. A. **117**:1318-1321 (Oct. 18) 1941.

width apart. He should fall forward in a roll so that the shock may be broken at the knees and the ankles.

Procaine Hydrochloride Technic in the Treatment of Fractures.—Ferguson and Erb [87] discuss in some detail the rationale of the proper selection of cases and outline the results of injecting procaine hydrochloride and using early mobilization in the treatment of non-weight-bearing fractures. In discussing the theory they credit Leriche with the best rationalization of the effect of procaine hydrochloride; which is briefly that the swelling and edema caused by the trauma is the result of a secondary vasospasm which is an axon reflex. This can be interrupted either by injection into the sympathetic ganglion or by local injection around the site of the injury. According to this theory the relief of pain is due not to the anesthetic effect of the procaine hydrochloride but to the relaxation of vasospasm which in turn reduces the edema and swelling of the part. The authors feel that this plays an equal part with mobilization, since mobilization alone in many instances does not relieve pain. On the other hand, mobilization is of extreme value, particularly in the region of joints since it permits joints to accommodate themselves to whatever irregularity has been caused by the fracture. Their method is simple; 1 or 2 per cent procaine hydrochloride without epinephrine is injected into the point of maximum tenderness until the tenderness entirely disappears. If this occurs after eight to twelve hours, another injection is given and may be repeated as often as the pain recurs. The authors stress the fact that it is not always advisable to begin mobilization immediately, although this should be begun as early as possible. If there is extreme swelling of the area before treatment, it may be necessary to wait a few days for this to subside before mobilization is begun, although injection is carried out immediately. They point out also that the weight-bearing bones of the lower extremity, or those in which immobilization is required to maintain reduction, are not suitable for this method. They bring out also the fact that the efficacy of therapy does not rely alone on this relief of pain but that it permits the patient to begin to resume his normal activity much more rapidly than with the older type of treatment by external fixation. They report 84 cases in 80 of which treatment consisted of injection of procaine hydrochloride and early mobilization. The majority of the fractures were about the ankle, the tarsus and the metatarsus, the phalanges, the upper part of the humerus, the elbow, the metacarpals and the wrist. A detailed discussion is given of each group. In conclusion, they point out:

> Many minor fractures are best treated by early mobilization and procaine injection. The procaine injection at the site of fracture or into the sympathetic

87. Ferguson, L. K., and Erb, W. H.: Procaine Injection and Early Mobilization in Non-Weight Bearing Fractures, Ann. Surg. **114**:293-308 (Aug.) 1941.

ganglia interrupts the reflex which produces vasomotor changes, edema, and pain at the injured site. Early mobilization is thereby permitted, and rapid and excellent fracture healing results. The period of disability is reduced and the eventual end-result is improved in many instances, especially in articular fractures. . . . Only fractures which do not require reduction in non-weight-bearing bones can be treated by this method.

[ED. NOTE: This is a thoroughly stimulating discussion of this subject and in our opinion is presented with the sanest outlook and the least prejudice of any of the many articles on this subject which have appeared in the literature. The authors have analyzed their results carefully and have wisely refrained from attempting to apply this method to every type of fracture. It is worthy of considerable study.]

II. FRACTURE DEFORMITIES

Fracture Healing.—Physiologic and pathologic processes of bone metabolism with particular reference to chemical and biochemical factors in demineralization and bone growth have been the subjects of articles during the past year. Experimental and clinical data have been correlated, but no fundamental advance has been achieved in this field.

Urist and McLean [88] present microscopic studies of the healing process of fractures of fifteen litters of normal rats and describe the steps of fracture healing as it probably occurs under optimum conditions.

The first reaction to injury is sterile inflammation associated with trauma and hemorrhage. The bone defect is filled and surrounded by extravasated blood and inflammatory exudate. The reparative process begins with the formation of connective tissue (fibrocartilaginous callus) which differentiates into hyalin and fibrocartilage. While this process is taking place, new bone formation begins under the periosteum and endosteum at some distance from the fracture site. This new bone progresses and invades and replaces the fibrocartilaginous callus, and this results in bony union.

Calcification begins in the new bone matrix formed subperiosteally and subendosteally and progresses toward the fracture site as quickly as the new bone matrix is formed. This matrix is calcifiable as soon as it is recognizable as osseous tissue. The matrix of hyaline cartilage becomes calcifiable when the adjacent cartilage cells become vesicular or hypertrophic. Only tissues recognizable as bone matrix or cartilage matrix calcify, and of this matrix only that in contact with the invading bone calcifies in the final callus.

Urist and McLean extended their studies of normal callus formation to observation of the effect of phosphate and vitamin D on the control

88. Urist, M. R., and McLean, F. C.: Calcification in Callus in Healing Fractures in Normal Rats, J. Bone & Joint Surg. **23**:1-16 (Jan.) 1941.

of callus formation in rachitic rats. They found that in the rachitic rats the healing of fractures begins as it does in normal rats with the important difference that the healing process proceeds in the complete absence of calcification of the newly formed tissues for the first ten to fifteen days following the injury.

In the normal animal about the fourth day the intramembranous bone formed under the periosteum and endosteum has gained contact with the fibrocartilaginous callus, and its removal and replacement by bone are well under way.

In the rachitic animal there is a lag in the replacement of callus tissue by the newly formed osseous tissue, often until the ninth to twelfth day; this corresponds to the delay in calcification at the epiphysial line.

Calcification in the osteoid of the callus as well as in the epiphysial cartilage may be initiated by a single dose of phosphate. A diet inadequate in phosphate but supplemented by vitamin D does not produce rickets or manifestations of the absence of calcification at the fracture callus.

In connection with experimental work on the effect of estrogenic substances on callus production, Pollock and Ghormley [89] noted certain changes in the bone tissues distant from the fracture site which appeared to be of sufficient interest to warrant further study. It was demonstrated that the periosteum of the fractured humerus in the rat underwent stimulation and thickening not only in the area adjacent to the fracture site but all the way to the surgical neck. The authors state that this appeared to be the result of a general stimulation rather than the result of local trauma.

Hills and Weinberg [90] observed the effect of estrogen therapy clinically in 3 cases of delayed union or nonunion in fractures. Their conclusion is that callus formation in these cases was definitely influenced favorably by the use of estrone (theelin).

The results of their efforts to substantiate this clinical observation by experimental work on dogs and cats were not so striking as they anticipated. However, the authors feel justified in concluding that 9 of 13 cats and 6 of 7 dogs showed earlier and more abundant callus formation under estrogen therapy.

[ED. NOTE: None of the data published during the past year relating to the effect of estrogen therapy on the healing of fractures alters the conclusion drawn from previous publications, viz., that the administration of estrogens or any other endocrinotherapy has no practical

89. Pollock, G. A., and Ghormley, R. K.: Early Repair of Bone: Experimental Study of Certain Factors, J. Bone & Joint Surg. **23**:273-279 (April) 1941.

90. Hills, R. G., and Weinberg, J. A.: Influence of Estrin on Callous Formation, Bull. Johns Hopkins Hosp. **68**:238-247 (March) 1941.

effect on the healing of fractures. The problem of nonunion still appears to be more local than constitutional.]

Murray,[91] basing his conclusions on the practical data gained by the intensive research of the last quarter of a century, notes the nature of the tissue reaction following fractures and states that the time and the method of treatment should be based on an understanding of the physiologic and pathologic tissue conditions present.

The chronologic time at which the various stages of tissue repair occur varies considerably in each individual patient. Hence time as gaged by hours or days means little except in establishing an average. Time refers to the stage of progress the pathologic condition has reached. It is to be interpreted in terms of clinical evidence, such as the character and the extent of swelling, pain, tenderness, edema, infiltration and ecchymosis. The logical rule to follow is to treat the fracture in accordance with the pathologic condition present, regardless of chronologic time elapsed since injury, by modifying whatever method the surgeon is best capable of handling effectively.

The influence of the timing of the process on the choice of method is illustrated by the author's citations of his clinical conclusions based on the results observed in twelve years' experience in a large fracture service conducted on the aforementioned principles.

The time schedule of the development of tissue reaction after fracture dictates the technic of traction-suspension as a method of treatment. Reduction, so far as length is concerned, should be attained as early as possible, preferably in the first four hours, before the muscles have begun to lose their elasticity from infiltration. Overpull is safe before muscle fixation has occurred but should be avoided afterward.

Open reduction of fractures requiring this procedure is best done within the first four to eight hours after injury. During such an early operation the escape of blood and exudate from the tissues leads to a minimal soft part lesion with its functional implications and on the basis of the author's conception of the healing process to more certain and quicker calcification of the healing tissue to form callus.

The least satisfactory time for open reduction of a fracture is between the twelfth and the twenty-eighth day.

Recent fractures treated by open reduction followed by cast immobilization take longer for bone healing than similar fractures treated by closed methods. This is particularly true if the operation is done some days after the healing processes have started. To the pathologic process already fixed in the tissues is added the damage of operative trauma. Early emergency operation with internal fixation rigid enough

91. Murray, C. R.: Timing of Fracture-Healing Process: Influence on Choice and Application of Treatment Methods, J. Bone & Joint Surg. **23**:598-606 (July) 1941.

to allow active mobilization postoperatively in counterbalanced suspension not only restores joint and muscle function more promptly but promotes the speed and certainty of fracture healing.

From the points just mentioned it is obvious that the principles of reduction as soon after the injury as possible are applicable to all methods of reduction.

It is the author's belief that students can derive a more sound understanding of the basic principles which underly fracture treatment as a whole if they think more of what any method of treatment accomplishes in guiding the pathologic process after treatment and less about the technical details of each method. The ability to interpret physical signs as indicative of the pathologic state present and of the speed with which it is progressing is a sound basis for the intelligent use of any method of treatment.

Pseudofractures.—Camp and McCullough [92] present a comprehensive review of the various conditions exhibiting pseudofractures. Pseudofractures may be described as transverse zones of rarefaction varying in width from less than a millimeter to more than a centimeter. They are frequently mistaken for true fractures, and since in reality they are generally an indication of certain weaknesses or dysfunction of the skeletal system, it is important that their true character be identified.

They have been reported by various authors under a variety of names, such as pseudofractures, Looser's zones, multiple spontaneous idiopathic symmetric fractures, osteoporosis myelolytica, insufficiency fractures and march fractures. The authors state that none of these conditions constitute a clinical entity but are simply a manifestation of excessive strain either of normal or of weakened structure.

Pseudofractures occur in a variety of diseases which have no relation to each other. Studies of Looser of the nature of these defects in association with osteomalacia and rickets stimulated wide interest in these subjects during the food shortage in Europe following the first World War.

Roentgenographically these skeletal defects show three different forms: (1) those associated with certain malacic diseases, which may appear as small subperiosteal notches in the cortex and which progress across part or all of the cortex as a band of decalcification without disturbance in the continuity of the bone; (2) those lesions not associated with malacic diseases, which may be revealed as cracks or fissures extending through the cortex on one side, usually the convex side, of pathologically curved bones; (3) those lesions which appear as fusiform callus formations only, no crack or decalcification being apparent roent-

92. Camp, J. D., and McCullough, J. A. L.: Pseudofractures in Diseases Affecting Skeletal System, Radiology **36**:651-663 (June) 1941.

genographically (these lesions seem to be identical with the so-called march fracture).

[Ed. Note: Exception must be taken to the statement that this third type consists entirely of a fusiform callus without a fracture in the cortex. March fractures, which are a typical example of this type, will regularly show a fracture line if serial roentgenograms are taken.]

Pseudofractures are most commonly found in the tibia, the forearm, the pelvic bones, the metatarsal bones, the ribs, the radius and the ulna.

In many cases the condition is associated with hunger osteomalacia, rickets or late rickets. In other cases it occurs in normal bones after unusual strain or repeated minor strains. In the latter cases it resembles the breaking of a wire by multiple minor cracks resulting from repeated bending.

Biopsy and microscopic studies of these fracture lines have not demonstrated any unusual pathologic condition. Honigmann and the authors found only increased lacunar absorption and the development of meshlike bone without calcification. Studies of the blood chemistry showed only those variations which might be expected with the underlying disease.

Macey[93] reports a single case of multiple pseudofracture with absence of phosphatase activity in the blood serum.

After a review of the voluminous literature covering the subject, Camp and McCullough conclude that pseudofractures do not represent a disease entity but that they are partial fractures due to excessive strain, which may take several forms, depending on the associated pathologic condition and on the nature of the excessive strain.

Nagura,[94] reporting the microscopic picture of the so-called transformation zones of Looser, says that he observed the area to be composed of an embryonic type of callus formation, both cartilage and fibrocartilage, on both sides of which osseous transformation was taking place. The zones represented an area of interrupted continuity about which reconstruction of bone was taking place. Similar zones of rarefaction have been found in osteochondritic diseases, such as König's and Perthes' disease.

Post-Traumatic Osteoporosis.—Herrmann and Caldwell[95] review the clinical and roentgen manifestations of acute post-traumatic osteo-

93. Macey, H. B.: Multiple Pseudofractures: Case (with Absence of Phosphatase Activity of Blood Serum), Proc. Staff Meet., Mayo Clin. **15**:789-791 (Dec. 11) 1940.

94. Nagura, S.: Nature of So-Called Transformation Zones (Looser): Cartilage Callus Zones, Zentralbl. f. Chir. **67**:1971-1975 (Oct. 19) 1940.

95. Herrmann, L. G., and Caldwell, J. A.: Diagnosis and Treatment (Including Periarterial Sympathectomy) of Post-Traumatic Osteoporosis, Am. J. Surg. **51**:630-640 (March) 1941.

porosis and clearly distinguish it from the osteoporosis of disuse. They agree with the concept of Nobel and Hauser that the only theory which can satisfactorily explain all the pathologic physiologic characteristics of bone in true osteoporosis is that the disturbance is a manifestation of trophoneurosis as originally suggested by Kienböck in 1901.

Treatment by the ordinary conservative means, such as physical therapy and active mobilization, have only slightly reduced the period of pain and dysfunction. Roentgen therapy, as advised by Mumford, has reduced the pain but has not materially shortened the period of disability or the final permanent loss of function.

The authors recommend periarterial sympathectomy and report the results in 34 cases of the acute painful variety treated by this method. All of the patients had relief of the severe pain within twenty-four hours with disappearance of edema and functional disturbance within a few days. The period of disability averaged three months in this series, while for those previously treated by nonoperative measures it was nine months.

The operation should be performed during the acute stage of the disease, since it is not successful in the subacute or chronic stage.

Carpinteri [96] reviews Sudeck's theory of acute post-traumatic bone atrophy. He then points out the practical conclusions to be drawn and summarizes them as follows:

1. Local injury to the bone causes a general skeletal reaction stimulating the phosphate-esterase capacity of all skeletal parts, which acts as a physiologic homogeneous organic system under these conditions as during growth.

2. Every injury, independently of its destructive effect, constitutes a direct injury to the mobility of the vessels leading to genuine active hyperemia.

3. The diminution of the density of shadow of a bone, far from indicating atrophy, is evidence of an intense process of ossification, and increased density indicates dying bone or eburnation.

4. Therefore, what Sudeck earlier described as acute bone atrophy constitutes only an accelerated metabolism in the bone. As the only reaction of the bone to various pathologic factors consists in loss of heavy salts, the radiologic manifestation of the syndrome must be designated as halisteresis.

Aseptic Necrosis of Cancellous Bone and Its Relation to Fractures.—In a comprehensive monograph Bozsan [97] correlates the historic and

96. Carpinteri, E.: Significance Modality and Roentgen Picture of Sudeck's Acute Atrophy, Gior. di med. mil. **88**:750-771 (Oct.) 1940.

97. Bozsan, E. J.: Compression of Cancellous Bone, Principal Manifestations in Head and Neck of Femur: Treatment by Connecting Drill Channels, Am. J. Surg. **53**:537-618 (Sept.) 1941.

the pathologic data relating to that group of diseases showing nutritional or growth disturbances in the head of the femur and the adjacent structures. This group includes such conditions as Legg-Calvé-Perthes disease, osteochondritis dessicans, epiphysial separation of the femoral head, malum coxae senilis and aseptic necrosis of the femoral head following fracture.

The author states that he has found an explanation that solves the question of the underlying cause of aseptic bone necrosis, and he explains on this basis the causation and the pathologic nature of all the related pathologic processes known under the various disease classifications already listed. The characteristic wedge-shaped areas of aseptically necrotic bone may be produced by a mechanism other than infection, namely, compression of a spherical wedge-shaped portion of cancellous bone.

The results of compression applied to a spherical-shaped body composed of cancellous material demonstrate: (1) that the compressed area is cone shaped; (2) that the compression does not damage the whole substance of the cone but is most effective on the jacket of it; (3) that within its compression pattern secondary component wedges are demonstrable, each impact producing its own wedge, and (4) that changes in the curvature of the surface and the speed of force alter the shape of the compression pattern.

By correlating these observations with the fact that all the diseases under consideration occur in cancellous bone and at places where the bone presents a more or less spherical surface, the author arrives at the concept of compression of cancellous bone, which he is convinced is the sole cause of all of these diseases and may be considered an entity because while manifest in a variety of clinical pictures it presents at all times the same pathologic features.

If cancellous bone is subject to a force which is greater than its maximum of structural strength, its structure will collapse, this collapse obeying the laws of mechanics. The minute girders of the cancellous structure break, and these broken trabeculae interrupt the blood supply to the inclosed cone. The necrosis thus produced is mechanical and not due to an embolus of a terminal artery entering the apex of the cone as presumed by Axhausen.

The parts of the skeleton that harbor these diseases contain, besides cancellous bone, also cartilage, particularly in childhood and adolescence. Cartilage is fundamentally different in its physical properties from cancellous bone and hence does not suffer the same effects from compression. The relative amounts of cartilage and bone present at the different age periods explain the different clinical forms observed in children and in adolescents.

Lagomarsino and Muscolo [98] describe a case of aseptic necrosis of the head of the humerus after a fracture-dislocation in which the roentgen and clinical pictures resembled that of aseptic necrosis of the femoral head following central fractures of the neck. In this case the aseptic necrosis of the humeral head was demonstrated by roentgen examination about ninety days after the injury. The condition progressed slowly, causing a disappearance of more than half of the epiphysis in a period of sixteen months.

[ED. NOTE: Aseptic necrosis of the humeral head has never been observed by one of us (J. S. S.), nor has this editor seen it described before in the literature. The age of this patient is not given in the abstract. An epiphysial disturbance during the growth period must be considered.]

There has been and still is considerable difference of opinion as to the best method of treatment for fractures of the carpal scaphoid.

Geissendorfer [99] states that conservative methods of immobilization in old fractures of the scaphoid have not proved successful. Surgical removal of the smaller fragment after nonunion has occurred is not satisfactory since a painful wrist usually persists. Drilling operations, as described by Beck and Schnek, have given some good results, but the author does not think this method provides the immobilization necessary to obtain union. He recommends nailing the fragments with a Kirschner nail and reports union with good results in 6 cases of old carpal scaphoid fractures. Complete immobilization is maintained in a cast for three months after operation.

Massart and Leger [100] recommend drilling of old scaphoid fractures after visual exposure of the fragments. They do not recommend more than one week's immobilization.

[ED. NOTE: The whole problem is still somewhat confused, chiefly because no one has had an opportunity to study the effects of various forms of treatment in any large series of cases, particularly in cases of acute fracture. The diagnosis is frequently overlooked in the acute stage because of inadequate roentgen examination or because fracture lines exist at the time of acute injury which cannot be seen in roentgenograms but which become apparent later after bone atrophy and absorption at the fracture site have taken place. This has been observed by one of us

98. Lagomarsino, E. H., and Muscolo, D. T.: Aseptic Necrosis of Head of Humerus After Its Fracture-Luxation, Arch. urug. de med., cir. y especialid. **17**: 450-457 (Oct.) 1940.

99. Geissendorfer, H.: Successful Therapy of Old Fractures of the Carpal Scaphoid with Nailing, Zentralbl. f. Chir. **68**:343-346 (Feb. 22) 1941.

100. Massart, R., and Leger, L.: Therapy of Painful Pseudoarthrosis of Carpal Scaphoid by Beck Operation, Mém. Acad. de chir. **66**:505-510 (May 1-8) 1940.

(J. S. S.) both in cases of fracture of the carpal scaphoid and in cases of central fracture of the femoral neck. In general the problem appears much the same in these two types of fractures for the following reasons: 1. Complete immobilization by external appliances is difficult and is usually not obtained. 2. Union occurs entirely by endosteal callus, the formation of which is prevented by slight movement at the fracture site. 3. The blood supply to the fragments is inadequate. 4. Aseptic necrosis of one fragment is frequent, and this interferes further with union. While union may be obtained in many cases of fracture of the carpal scaphoid by external immobilization alone (as was accomplished by the Whitman method of treating central fractures of the femoral neck), it seems reasonable to expect that a corresponding increase of unions in carpal scaphoid fractures will take place if immediate internal fixation (providing adequate immobilization) is employed at the time of the acute fracture. Further use and reports of such treatment might be helpful.]

Fractures of the Neck of the Femur.—The modus operandi of union in fractures of the femoral neck has been the subject of much study and a voluminous literature.

Kulowski and Luck [101] were fortunate in obtaining the postmortem specimen of a fractured hip seven weeks after injury and six weeks after a satisfactory nailing with a Smith-Petersen nail. Their report of the microscopic study of the tissues at and adjacent to the fracture site, presumably at the height of activity in the healing process, is concise and informative. Grossly there was no evidence of periosteal callus. On frontal section of the specimen it was evident that an early stage of bony union had been obtained. The marrow of the capital fragment was fatty; all other marrow in the specimen appeared grossly hematogenous.

They report the microscopic examination of the fracture site as follows:

> The most outstanding feature of the fracture site was the presence of a multitude of fine-caliber, short, narrow, smooth trabeculae, more than half of which were still in the osteoid stage. Osteoclasts were conspicuous for their paucity. A moderate number of small osteoblasts were attached to the surfaces of some of the trabeculae. Most trabeculae appeared to have formed on the basis of fibrous tissue. These small young trabeculae were aligned in all directions, with no respect for static lines of stress. A few large mature trabeculae were also present in the fracture zone. Many of these trabeculae were dead, presumably as a result of separation from their blood supply at the time of the fracture. New bone was

101. Kulowski, J., and Luck, J. V.: Microscopic Changes After Internal Fixation of Transcervical Fracture of Femur, J. Bone & Joint Surg. **23**:17-22 (Jan.) 1941.

applied to the surfaces of numerous old trabeculae at and adjacent to the fracture site. A considerable degree of hyperaemia existed in the vessels of the fibrous marrow in this region. Marrow fibrosis was sharply limited to a zone approximately one-quarter inch wide at the fracture level. . . . Beyond this zone the marrow appeared quite normal. Not a solitary field of cartilage in any form could be found at the fracture site. The healing process appeared to consist simply of the formation of osteoid and bony trabeculae on the basis of reactive fibrous tissue which developed between the fragments and in adjacent marrow spaces.

The femoral head was viable and showed the same microscopic changes that have previously been reported.

The femoral neck and the trochanter revealed a good blood supply with viable trabeculae and marrow. There was no subperiosteal new bone or callus at or adjacent to the fracture site.

The authors conclude that if internal fixation is adequate the process of union by endosteal callus and bone formation is rapid and adequate enough to insure union much sooner than has been generally appreciated.

Ununited Fractures of the Femoral Neck.—The consensus of those who have given most thought to the problem of ununited fractures of the femoral neck is that no one procedure is suitable for use in all cases. Each case must be studied individually, and the various components as to the general condition of the patient and the local conditions of the fracture must be weighed before deciding which of several procedures appears most suitable.

Henderson [102] states that the ideal procedure is the restoration of bony union between the head and the neck in the normal anatomic relation. This is best accomplished by extra-articular osteosynthesis when conditions are favorable. He states that less than 10 per cent of ununited fractures of the femoral neck qualify for this procedure.

He describes the operative technic in which a fibular graft is used without other internal fixation and reemphasizes the previously published general and local requirements for the suitability of this operation. He reports 11 bony unions and 8 excellent results in 14 cases in which treatment was carried out by bone grafts.

Bickel and Ghormley [103] add 2 cases to those already reported of ununited fractures of the femoral neck successfully treated by the Brackett reconstruction operation. In both cases the femoral heads were viable, and no arthritic changes were present.

Several articles have appeared during the last year advocating the high type of osteotomy (McMurray) as the simplest and most

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102. Henderson, M. S.: Extra-Articular Osteosynthesis for Nonunion of Fracture of Neck of Femur, Arch. Surg. **42**:557-565 (March) 1941.

103. Bickel, W. H., and Ghormley, R. K.: Brackett Operation for Ununited Fractures of Neck of Femur: Report of Two Cases, Proc. Staff Meet., Mayo Clin. **16**:345-348 (May 28) 1941.

universally successful operation for ununited fractures of the femoral neck. Reich [104] reports the results in 26 cases in which this method of treatment was used. Osteotomy is indicated in all cases of nonunion in which the head was demonstrated roentgenologically to be viable. It is contraindicated in those cases in which there is definite aseptic necrosis or osteoarthritis of the ununited head.

The mechanical principle on which the operation is founded is that by shifting the upper end of the shaft medially directly under the femoral head the shearing force of weight bearing at the fracture site is eliminated or transformed into a direct weight-bearing thrust of the shaft against the femoral head.

The operative technic described by McMurray with the use of a wire for a guide was employed. The patients were immobilized in a cast for six weeks.

The functional and anatomic results were satisfactory in 22 of the 26 patients. In the average case the shortening is not increased over 1 cm., and in some cases there may be an actual lengthening. Union between the head and the neck occurred in every 1 of the 22 successful cases. At the time of last observation (the longest period since operation was five years) there was no evidence of secondary osteoarthritis or aseptic necrosis.

Jahss and Mintz [105] review 16 cases of ununited intracapsular fractures of the hip treated by high trochanteric osteotomy. There were 14 satisfactory results, 1 failure and 1 death. In 5 cases bony union of the neck fracture resulted, and in those remaining cases in which such union did not occur excellent functional results with regard to stability of the hip, relief from pain and adequate range of motion were obtained.

The authors state that osteotomy is applicable in cases of nonunion of short or long duration, regardless of the viability of the femoral head.

The operation may also be useful for fresh fractures in which satisfactory reduction cannot be obtained and for which internal fixation is therefore contraindicated.

The following possible technical errors at operation are listed: (1) incomplete medial displacement of the femoral shaft; (2) an acute angle of osteotomy, which is to be avoided; (3) wide abduction of the limb, which also is to be avoided; (4) too high a level of osteotomy, which will interfere with inward displacement of the shaft; (5) too low a level, which will result in excessive shortening.

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104. Reich, R. S.: Ununited Fracture of Neck of Femur Treated by High Oblique Osteotomy, J. Bone & Joint Surg. **23**:141-158 (Jan.) 1941.

105. Jahss, S. A., and Mintz, B. J.: Transverse Osteotomy in Ununited Fractures of Femoral Neck, Bull. Hosp. Joint Dis. **2**:143-153 (Oct.) 1941.

Early check of the position of the osteotomy and revision of the position if necessary are advised.

The usual residual shortening is about 1 inch (2.5 cm.), most or all of which was present before the operation.

Speed and Smith,[106] in an analysis of a series of 30 osteotomies, report results which compare favorably with those of reconstruction operations or bone grafts for osteosynthesis. In many of the early cases in this series the osteotomies were performed lower than the site now recommended by these and other authors. Even in this group, in which union between the head and the neck occurred in only about 25 per cent of the cases, the stability of the hip and the functional results were more satisfactory than those obtained by any of the various reconstruction operations.

For the entire series good or fair functional results were obtained in 80 per cent of the cases.

With the exclusive use of the high type of osteotomy the good results have been increased from 53 to 75 per cent; fair results have been reduced from 23 to 15 per cent, and poor results have been reduced from 23 to 10 per cent.

The authors consider that the ideal site for osteotomy is that corresponding to the level of the lower border of the femoral head, preferably passing through the trochanter just above the lesser trochanter. When union occurs after such osteotomies between the shaft and the head, between the head and the neck and between the shaft and the trochanteric fragment, the final result closely approximates the normal hip both anatomically and functionally.

In discussing the indications for osteotomy, the authors state that it will be necessary to study a large series of cases over at least a five year period before forming any positive conclusions. In general, however, present experience justifies the conclusion that osteotomy is preferable to reconstruction operations for the following reasons: 1. The operative technic is safer and simpler. 2. The mechanics of osteotomy more closely restore anatomic conditions for weight bearing in the hip. 3. Subsequent displacement and loss of support are less likely. 4. Function surpasses that of the best reconstructions and approximates that of osteosynthesis.

Osteotomy is contraindicated: (1) when the requirements are suitable for a bone graft or osteosynthesis; (2) if the fracture is of long duration and there is a small absorbed head with extreme lateral and upward displacement of the trochanter, where a reconstruction is preferable; (3) if an obviously necrotic head with osteoarthritis of an

106. Speed, J. S., and Smith, H.: Trochanteric Osteotomy for Ununited Fractures of Neck of Femur, South. M. J. **34**:798-806 (Aug.) 1941.

excessive degree is present (aseptic necrosis of the head without arthritic changes is not considered a contraindication since material improvement in the nutrition of the head has frequently been observed following union with the shaft and the neck).

The operative technic recommended is similar to that described by McMurray except that sufficient exposure to divide the bone under direct vision is advised in order to insure a clear line of division with the proper inclination and without projecting or detached fragments.

The authors recommend a minimum period of cast immobilization of eight weeks and up to twelve weeks if union does not appear solid. In some cases displacement has occurred after only six weeks' immobilization. The general condition of the patient may necessarily terminate cast immobilization earlier than is desirable

A position of slight flexion at the hip and the knee with a hinge joint in the cast at the knee reduces the joint stiffness.

The position of the osteotomy should be checked by roentgen examination through the cast at the end of three weeks, and if displacement has occurred, satisfactory reposition should be secured with the patient under general anesthesia, either by manipulation or further open operation.

[ED. NOTE: These reports constitute a valuable contribution to the problem of treatment of nonunion of the neck of the femur. Experience has shown that osteosynthesis is suitable for use in only a small percentage of the cases of nonunion. Reconstruction operations materially alter the normal anatomic weight-bearing conditions at the hip, and per se the percentage of good functional results leaves much to be desired. Whether the method of high trochanteric osteotomy reported in these articles will materially change the picture only time and the study of end results in a large number of cases can determine. Certainly the mechanics of the procedure are based on sounder principles than any of the reconstruction operations.]

Delayed Unions, Malunions and Nonunions of Fractures of the Long Bones.—Speed [107] classifies delayed unions of bone into (1) clinical, (2) roentgenologic and (3) functional.

Clinical delayed union is expressed by instability at the fracture plane, a tendency to develop a slowly progressive deformity or bowing and persistent swelling with edema and some localized pain at or near the fracture site. Continued pain and localized soreness in the fracture area after first mild attempts at active use always indicate delayed union and the necessity for further protective immobilization.

107. Speed, K.: Delayed Union of Bone, S. Clin. North America **21**:245-257 (Feb.) 1941.

Roentgenologic delayed union may be accompanied by all or none of the clinical findings. Roentgenologic delayed union is most often found in the peripheral bones, such as the carpus, the phalanges of the fingers or the toes and the scapula. The roentgen findings are demonstrated by a faint cloudiness of shadow between the fracture surfaces, which usually have lost their sharp edges, without excess callus. Calcification seems strikingly lacking; sclerosis of the fracture ends is lacking and, if it appears, may be accepted as definite evidence of nonunion.

Serial roentgenograms should be taken with exactly the same technic of exposure and interpreted by the same person, preferably the surgeon in charge who is familiar also with the clinical data.

Functional delayed union may be distinct from the other two types or combined with them. It is often betrayed by a complaint of weakness in the part, by delayed functional use and possibly by swelling and sensory and vascular changes of varying degree, mostly inexplicable on a clinical or a roentgenologic basis.

Some of these situations are explicable by factors under the control of the patient, e. g. psychic reaction, medicolegal controversies or malingering; others are to be explained on the basis of disturbed function, e. g. those due to age, cardiac action or endocrine and vitamin deficiencies.

The author discusses the various factors in the development of delayed union and their control. From the surgeon's standpoint, these include early adequate reduction of the fracture, the use of the proper type and length of immobilization, delay in active use of the extremity until callus formation is well advanced and a realization on the part of the surgeon that there is no short cut to bony union.

From the patient's standpoint, aside from such factors as age and condition of the vascular system (which are known factors), the more speculative considerations of physiologic and hematologic data, including blood chemistry, endocrine function and vitamin balance, must be taken into account.

It may be assumed that in a normal patient with adequate diet these factors are not material, but this should not prevent one from being on the alert to detect abnormalities of this type which might adversely influence the healing of fractures.

Milch [108] reports a case of delayed growth of the radius with relatively increased length and dorsal dislocation and painful instability of the ulna following an old fracture of the radius. The condition was corrected by cuff resection of the ulna, restoring the relative length of the two bones at the wrist. The ulnar prominence and instability and

108. Milch, H.: Cuff Resection of Ulna for Malunited Colles' Fracture, J. Bone & Joint Surg. **23**:311-313 (April) 1941.

the painful dysfunction of the wrist were corrected. The same procedure is recommended for similar deformities following Colles' fractures in adults, although no reports of results are given.

Campbell and Boyd [109] report the use of vitallium screws as a method of fixation for onlay bone grafts in the treatment of ununited fractures. Campbell previously reported the end results of onlay bone grafts held by autogenous bone nails in 235 cases of nonunion; bony union was obtained in 93.6 per cent of the cases.

The present report includes an additional 60 cases in which vitallium screws were substituted for the autogenous nails as a means of fixation for the graft. End result study in this group shows bony union was obtained in 93.2 per cent, eventually the same as in the previous group.

The authors conclude: (1) that the use of vitallium screws rather than autogenous bone pegs for fixation of onlay grafts simplifies the operation; (2) that better mechanical fixation of the graft is afforded; (3) that bony union is obtained in practically an equal number of cases by the two methods, and (4) that the theoretic disadvantage of introducing a foreign body has little actual significance since vitallium is apparently inert in the tissues.

Stuck [110] advocates removal of tibial grafts of the massive onlay type with an osteotome in preference to a motor saw. He states that the grafts removed in this manner have the advantage of raw irregular edges and are not devitalized by overheating. These two features help in more rapid healing of the graft. He has used the method satisfactorily in 28 cases.

Meyerding and Cherry [111] report the technic and the end results in 15 cases in which some type of fibular stabilization or transplantation was performed for tibial defects. In 5 cases the loss of tibial continuity was due to hematogenous osteomyelitis; in 9 cases it was due to fractures, and in 1 it was due to pathologic fracture associated with osteomyelitis.

Various combinations of fusion of the upper or the lower end of the fibula to the tibia and fusion combined with transplantations of either the upper or the lower end or both ends of the fibula to the tibia were used according to the requirements of the bony defect present. In most of the cases there had previously been either primary osteo-

109. Campbell, W. C., and Boyd, H. B.: Fixation of Onlay Bone Grafts by Means of Vitallium Screws in Treatment of Ununited Fractures, Am. J. Surg. **51:** 748-756 (March) 1941.

110. Stuck, W. G.: Preparation of Autogenous Bone Grafts with Osteotomes, Am. J. Surg. **51:**350-353 (Feb.) 1941.

111. Meyerding, H. W., and Cherry, J. H.: Tibial Defects with Nonunion Treated by Transference of Fibula and Tibiofibular Fusion, Am. J. Surg. **52:**397-404 (June) 1941.

myelitis or infection in connection with compound fractures. In 5 cases recurrent drainage occurred from preexisting osteomyelitis. In 3 cases in which fusion of the upper tibiofibular articulation was done, temporary peroneal palsy resulted.

In spite of such minor complications the final result in 15 cases was good, i. e. the patient had a limb which was satisfactory for weight bearing without support.

The various modifications and combinations described by the authors have wide applicability to tibial defects when for various reasons tibial grafting is contraindicated or needs reenforcing.

Wilson [112] gives a detailed description of a simple method of two stage transplantation of the fibula to the tibia for use in cases of complicated and congenital pseudarthrosis of the tibia.

The author states his belief that this method which fuses the upper and lower ends of the shaft of the fibula to the tibia is superior to the method of fusing the upper and lower tibiofibular articulations.

Wilson says that he believes the transference of the fibula into the tibia has a wide range of application and should be considered for all complicated or infected pseudarthroses, even if there is no great loss of tibial substance, particularly in cases in which tibial grafting appears of doubtful advisability.

The details of the operative technic, which is a two stage procedure, are accurately described.

Complete immobilization in a plaster cast is used for several months, and brace protection is maintained until the stability of the leg is assured.

The type of fibular transplantation described with the addition of bone grafts to the tibia in 5 cases was used in 4 pseudarthroses of the tibia following old compound fractures and in 5 congenital pseudarthroses. Union occurred in all the tibial pseudarthroses. Even in those cases in which additional tibial grafts were used the author feels that union was primarily due to the stability afforded by the fibular transplant. In 5 of the 9 cases spontaneous union of the tibia occurred as soon as the fibular transplant became fused to the tibia.

Congenital Pseudarthrosis.—Kite [113] reports the results in 15 cases of congenital pseudarthroses. He states that while cystic areas have been observed in many of the tibias before fracture occurs it is not a form of osteitis fibrosa cystica which is a general systemic disease while congenital pseudarthrosis is a local condition. Many patients show

112. Wilson, P. D.: Simple Method of Two Stage Transplantation of Fibula for Use in Cases of Complicated and Congenital Pseudarthrosis of Tibia, J. Bone & Joint Surg. **23**:639-675 (July) 1941.

113. Kite, J. H.: Congenital Pseudarthrosis of Tibia and Fibula: Report of Fifteen Cases, South. M. J. **34**:1021-1032 (Oct.) 1941.

neurofibromas and café au lait spots which suggest a relation to von Recklinghausen's neurofibromatosis.

Owing to the high percentage of operative failures previously experienced most of the earlier writers on this subject advised delaying operation until the child was 6 to 8 years old. Kite disagrees with this because of the increase in permanent shortening and deformity of the leg if pseudarthrosis is permitted to persist for such a length of time. In the light of improvements in operative technic it appears that his contention is correct and that better functional extremities will result the earlier union in the tibia is secured.

In only 1 of Kite's cases was the fracture found at the time of delivery. In 8 of 15 cases the fracture developed during the first year and in 12 before the third year.

In all cases of this series the grafts used were autogenous; in most cases the "bone flap onlay graft" advised by Thornton was employed. In 11 of the 13 cases in which operation was performed bony union was eventually obtained, in some cases after two or more operations. The average shortening in 6 patients followed up to sixteen years was 10 cm.

Boyd [114] has developed and described a new principle in operative technic for congenital pseudarthrosis which apparently offers a much more certain method of attack on this difficult reconstructive problem. He uses a dual homogeneous graft which obviates many of the objections to the single graft and permits earlier operation in that the patient is not used as a source of the graft. Boyd also advises early operation to prevent deformity.

While a number of successful unions have been obtained by single massive grafts or by the multiple bone chip method described by Hallock, a study of the end results of such operations reveals definite criticisms. First, in a case of congenital pseudarthrosis the bone may be too soft to enable the threads in the vitallium screws to secure a firm grasp. Second, although a large amount of cancellous bone is packed about the fracture site, this bone is compressed by the organizing and contracting scar tissue which forms postoperatively about the fracture site. This results in a hemihourglass constriction at the site of union and a diminution in the size of the tibia at this point. This constriction predisposes to refracture and hinders the establishment of a marrow cavity through the former site of pseudarthrosis. This hemihourglass type of union also occurs in cases in which a defect in bone is bridged with an onlay graft and the defect is filled with cancellous bone. These factors are especially marked in cases in which the bone fragments are pointed at the ends. To overcome these objections it was decided to use the

114. Boyd, H. B.: Congenital Pseudarthrosis: Treatment by Dual Bone Grafts, J. Bone & Joint Surg. **23**:497-515 (July) 1941.

dual bone graft. The advantages of this method are: 1. Better mechanical fixation is obtained. 2. The tibial grafts are revascularized slowly and provide rigid internal fixation over a long period. 3. The cancellous bone about the fracture is revascularized quickly and produces a strong osteogenic element. 4. With a single graft the screws may fail to hold in osteoporotic bone; with the dual graft a clamp is formed which compresses the tibial fragments between the two grafts. 5. The grafts form a trough to hold the cancellous bone which is packed around the fracture. 6. The grafts prevent compression of the cancellous bone by contracting fibrous tissue during the healing process. Hemihourglass constriction of the bone at the fracture site is minimized. 7. The diameter of the grafted bone is increased. 8. Partial absorption of one graft does not necessarily result in refracture and failure, since the second graft maintains internal fixation.

The operative technic is described in detail. It consists essentially in the use of two massive homogeneous onlay grafts placed across either side of the fracture site and spanning as much gap as necessary to maintain the full length of the leg. The grafts are held to the tibial fragments and to themselves by vitallium screws passing completely through the tibia and both grafts after the manner of a wood clamp. The space between the grafts and about the end of the fragments is filled in with cancellous bone.

The possible objection to homogeneous grafts is apparently answered by successful results in the 4 cases in which this method has been used as a corrective measure.[115]

[ED. NOTE: It has been the privilege of one of us (J. S. S.) to follow these patients throughout the entire course of their treatment, and it appears from the results obtained that the technic described is a definite contribution to the treatment of congenital pseudarthrosis. Mechanically and physiologically the operation is based on sound principles. The attack is more direct, and the anatomic restoration of the tibia more nearly approaches the normal than that achieved with any of the other types of grafts or with such indirect methods as transplantation of the fibula. While the series is too small to permit forming a final judgment, the evidence so far is most encouraging. The use of the dual graft has been extended to the treatment of many other difficult types of nonunion, particularly those in which there are small atrophic terminal fragments adjacent to joints or in which it is desirable to span a gap. The results have been most satisfactory.]

(To Be Continued)

115. Boyd, H. B.: Personal communication to J. S. Speed, July 1942.

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